The City of Chula Vista
Fire Department

Fire Facility, Equipment, and Deployment Master Plan

Prepared by
Gene Begnell

March 12, 2012

Emergency Services Consulting International

Table of Contents

Table of Figures

Preface

This update to the 2006 Fire Facility/Deployment Plans consists of the following tasks:

Task 1 - Validate New Deccan Model

- Compare actual calls to model outputs
- Ensure street network in valid
- Check geo-coding of incidents and workload factor
- Validate model assumptions with staff to ensure that correct factors are being considered and appropriately modeled

Task 2 - Update Data Assumptions

- Population projections
- Call load projections
- Station locations
- Street updates with projected streets at build-out

Task 3 - Critical Task Analysis

- A new critical task analysis will be conducted to evaluate for fireground efficiency, including justification for heavy first response (four personnel per unit)

Task 4 - Deployment Issues/Solutions:

- Four personnel engines
- 1710 Compliance
  - Four-minute travel for first unit
  - Assemblage of Initial Attack Force (4 FF for two-in/two-out)
  - Eight-minute travel for Effective Fire Force
- Final build out with validation of the correct number of stations needed and evaluation of the need for the 15 stations used in the original report
  - Variations based on availability and use of automatic and mutual aid through AVL
  - Variations based on actual infrastructure vs. proposed
  - Variations based on integration of ambulances for first unit responses on ALS

Executive Summary

This study was designed to update the previous work done to provide a Fire Facilities and Deployment Master Plan for the Chula Vista Fire Department (CVFD) through buildout of the existing city boundaries. Future development was examined in accordance with the current General Plan and expected future growth as envisioned by the city through the year 2030 to evaluate the “issues” and “opportunities” that exist to provide Fire and Emergency Medical Services to the city in a manner that provided the high quality service that the citizens of Chula Vista have come to expect from their fire department.

Issues

Generally speaking, deployment is measured with three concepts - **distribution** (what and where), **concentration** (how much), and **reliability** (how well).

A successful distribution network means that the system is capable of providing a resource to the scene of an emergency with the correct equipment, apparatus, and staffing to complete the following:

- Assessment of the situation
- Establishment of a plan of action capable of mitigating the emergency
- Request for appropriate resources (if needed)
- Intervention to stop/impede the escalation of the emergency

Primary **distribution** within CVFD is accomplished with the engine companies. Each engine company covers a primary portion of the City. The City currently has eight engine companies housed in every fire station except Fire Station 3, which houses a single resource (Urban Search and Rescue Unit). The same is true for specialized resources such as truck companies and battalion chiefs. The City currently has two of each, housed at Station 1 and Station 7.

The current delivery system has evolved over time reacting to growth, calls for services, opportunities for land, and availability of funds. This was accomplished with logic, experience, and years of understanding what it takes to deliver service to the homes and on the streets of Chula Vista.

The primary performance measure that drives the distribution/location of fire stations for the CVFD is travel time. The first measure is the arrival time of the first unit to the scene of the emergency. Using a performance measure of having the first unit arrive within four minutes travel time (begins when unit is enroute to the call and ends with the arrival of the unit at the scene of the emergency), the current level of performance is at the 73rd percentile. At five minutes travel time, the performance is at the 89th percentile.

If distribution of resources is "*covering the dirt*"; concentration of resources is "*covering the calls*". A successful concentration network means that the system is capable of providing a resource to the scene of an emergency with the correct equipment/apparatus and staffing to complete the following:

- Stop the emergency from continuing to escalate
- Provide for the safety and security of citizens and emergency workers
- Complete all critical tasks in a timely manner
- Provide for incident management

Concentration is achieved in two ways: First is the spacing of the fire stations; second is in the staffing/equipment deployed in each fire station. The spacing of fire stations was a primary concern in the distribution of resources but plays a role in the concentration of resources as well. In Chula Vista, fire stations on the west side are spaced more closely than those on the east side. This has a particular impact on the timing of the second arriving engine

While several measures of performance are available to examine the concentration of resources, two are particularly good. These are IAF (Initial Attack Force) and EFF (Effective Fire Force). These measures are used by the Commission of Fire Accreditation International, the benchmark points for the National Fire Protection Association in *Standard 1710* and for IAF the number personnel required to enter a hazardous atmosphere according to OSHA. IAF is the assemblage of four personnel to allow for the fire crews to enter the structure and fight the fire while having enough resources outside of the structure to rescue the firefighters if something unforeseen was to happen. EFF is the assemblage of enough equipment and manpower (14 firefighters) to bring a routine structure fire to a positive conclusion.

A critical task analysis (CTA) was conducted to identify/validate needed resource distribution and staffing patterns. It was determined that a moderate risk fire response needs to consist of three engine companies, one truck company, and one battalion chief. A total of 14 personnel are needed to complete an EFF. Additionally, it was determined that four personnel are needed for the IAF. Two are used to enter the IDLH (Immediately Dangerous to Life and Health) atmosphere and two that need to remain outside of the IDLH as a rescue team in the event of a problem with the entry crew. This action is required by OSHA.

Distribution

The Fire Department goal of "first unit in four minutes travel time at 90 percent" is difficult to achieve. The modeling used here projects 24 stations are needed due to the nature of the street network combined with the sprawling nature of the development. First unit travel performance is achieved to the 77th percentile when the EFF is achieved to the 90th percentile (11 stations). Due to the extreme impact of tripling the number of fire stations, specific locations have not been detailed in this report. It should be noted that the 90th percentile can be achieved in five minutes when the EFF is achieved at the 90th percentile. Some thought and discussion should be directed at revisiting the four-minute timeframe in light of the analysis that has been conducted or to using the IAF and EFF standards as the primary goals.

As indicated earlier, with the current staffing, a second unit must arrive to assemble an IAF. In the critical task analysis section of this report it has been established that a three-person crew will take approximately 2.5 minutes (2:30) longer to be prepared to enter a burning structure. As noted, one in five calls (20 percent) have the second engine arriving three minutes after the first and for one in ten calls (10 percent) the second unit is nearly four minutes (3:49). These delays allow the fire to gain a large amount of momentum that will require even more resources to control and will significantly reduce the chances of survival for occupants and the ability of the fire department to limit damage.

The only deployment that guarantees a rapid IAF on every fire will be to staff each unit with four personnel. Until system-wide staffing is at four persons per unit, it is possible to indicate which units have more exposure to this issue. Stations with two resources are not as critical as standalone units. Fire stations located on the perimeter (FS04, FS06. FS08, EUC, and VILLAGE 8) have a greater chance of not providing a second unit in a timely manner. Staffing for four-person crews at these locations should be given serious consideration.

The overwhelming conclusion from three national studies conducted in the past year is that crew size has a direct relationship to the time it takes to complete critical tasks on the emergency scene. Time is the determination of success and failure in fire and EMS calls. Quicker suppression of fires keeps them smaller and limits the possibility of harm to the citizens and their homes. Time in nearly all critical care EMS calls is the one common denominator that has a direct relationship with outcomes for patients. The sooner a patient receives the proper care (in the field or hospital), the more likely the patient will have a positive outcome. *In all three studies, staffing of four personnel was optimal and provided significant increases in efficiency for the emergency crew while increasing safety to the responders and victims alike.*

<u>Concentration</u>

The current performance for IAF is 64 percent. The current performance for EFF is 82 percent (87 percent in model). The 2030 workload and additional area to be covered reduces EFF performance to 78 percent. That reduction is effectively reversed with the addition of the Eastern Urban Center (EUC) fire station; however, as staffing and stations are increased to deal with First Unit Travel and IAF, EFF rises to over 90 percent. To accomplish this, an additional truck needs to be added and EUC, BAYFRONT and VILLAGE 8 stations need to be constructed to get to the 90^{th} percentile.

With future increases in workload, the number of stations is not expected to increase (either with the JPB proposal or the university). Development may shift or change and will likely have slower periods from time to time. Phasing of station construction will need to match the development. The resort area has not been used in this calculation and will remain an outstanding issue until more specific information, timing, and infrastructure are determined.

Dual use apparatus/cross staffing is a concept that can be used successfully for wildland engines, water tenders, and other specialty units. The ability of the department to quickly field wildland resources is important to the probability of extinguishing these fires while they are still small enough to do so without a large number of resources. Consideration in the construction of a fire station for the parking of specialty apparatus should be undertaken and space for at least three or four wildland specific resources (brush trucks, water tender, patrols) should be incorporated into the new fire stations that are being projected.

Opportunities

FS01 – This station should be reconstructed at its current location with the ability to house three resources.

FS02 – The location that best maximizes this station is within one-quarter mile of Hilltop Drive and Whitney Avenue, with locations closer to H Street modeling better. This relocation will better serve the areas east of FS1. Access to the freeway is good as well. The current site of FS2 is acceptable but not optimal. A new site could be considered in the long-range planning.

FS03 – Relocating this station to Olympic Parkway and Oleander Avenue is the optimal location. Any site within one-quarter mile of this intersection is acceptable. This area balances area coverage with access to the freeway. The current location is acceptable but will not increase performance on rescue calls and will not house two resources if needed. The new site could be considered in the long-range planning.

FS04 – This station should be expanded to ensure that it can adequately house an engine and truck in the future. Since the trigger for this action in the call loading in EUC's first due, there is time to plan for this need and possible make the improvement with future improvements to the training grounds.

FS05 – Fire Station 5 is a candidate for relocation if the current site cannot be reconstructed to house additional resources. It could be relocated to the south approximately 0.5 miles. The optimal location would be 4th Avenue and Orange. This should be a future large station that will house an engine and the possibility of a truck or squad.

FS06, FS07, and FS08 – current sites and configuration are acceptable.

FS09 – Current location is acceptable but the station should be closed and the engine currently housed here relocated to FS03 when the USAR is collocated at the Bayfront fire station.

New Fire Stations

EUC – All three possible sites are in development areas. Site B, as identified, is optimal. Planning with the developer should begin to move the current site to Site B. When call loading within this area requires the need for a second unit, an additional truck company should be added at FS04 and the truck at FS07 should be relocated to the EUC station.

Bayfront – This station should be constructed near the intersection at J Street and Bay Boulevard. This area is currently underserved; given the expected growth in this part of the city, plans for this station are underway and should continue. This station should be constructed to house an engine and truck with consideration for moving the USAR to this location as well.

Village 8 – The exact location of this station will not be known until more precise plans are available for the development in this area. This station should generally be at La Media, south of Rock Mountain Road.

Future Development Outside of Current City Boundaries

Resort – This is a new station that may eventually house multiple companies. A site should be found within 0.25 miles of the center of the Resort Focus Area. A rural standard may need to be adopted by the City for this area and the Proctor Valley/San Ysidro Mountain District.

Conclusions/Recommendations

The Fire/EMS delivery system within the City of Chula Vista can be expanded to meet the expected growth of the community with the addition of three more fire stations for a total of 11 fire stations (with the closure of FS9 when the USAR is relocated) within the existing city boundaries. Each of these are development driven and will be provided by that development. Additional truck companies will be needed within the system and redeployment of existing resources will need to take place as they are added. Fire stations need to be constructed in a manner so as to accomplish these future changes without major cost and impacts to the facilities when they occur. Additional growth projected in the city at this time will be properly served with the station locations and configuration contained within this plan.

Staffing on the fire department units should be increased to provide the higher level of efficiency shown in the national studies and standards that are discussed in this report. While the current level of staffing is not unsafe, the 1984 Dallas Fire Department study's conclusion on three-person crews sums up the situation very well:

> *The three-person crew was able to control the fire although they were unable to complete the search of the lower level until after the fire was extinguished. At this*

staffing level, there was little margin for error and any appreciable delay in arrival might place the control of the fire beyond their capability.

This same conclusion was found in different ways in three recent national studies. First is the NIST (National Institute of Standards and Technology) Report, *Residential Fireground Field Experiment* (April 2010), second is the NIST Report, *EMS Field Experiment* (September 2010), and third is San Diego State University – Matt Rahn, Ph. D report, *Initial Attack Effectiveness: Wildland Staffing Study* (Summer 2010). As shown in these studies, the City of Chula Vista should seriously consider increasing crew size to four personnel.

Baseline and Operational Overview

The Chula Vista Fire Department (CVFD or department) is the operating department of the City of Chula Vista (City) designated to provide fire protection and emergency medical services. The department's jurisdiction encompasses the entire municipal limits of the city. The response area includes densely populated urban areas, as well as suburban residential areas and some undeveloped land of San Diego County, and is situated just a few minutes east of San Diego Bay.

The department began providing fire protection services in 1921. CVFD provides emergency services to a population of just fewer than 240,000 in an area of roughly 54 square miles. These services are provided from nine facilities located within the jurisdiction (Figure 1). The department maintains a fleet of vehicles, including eight fire engines, two aerial trucks, one Urban Search and Rescue US&R unit, and one wildland firefighting vehicle.

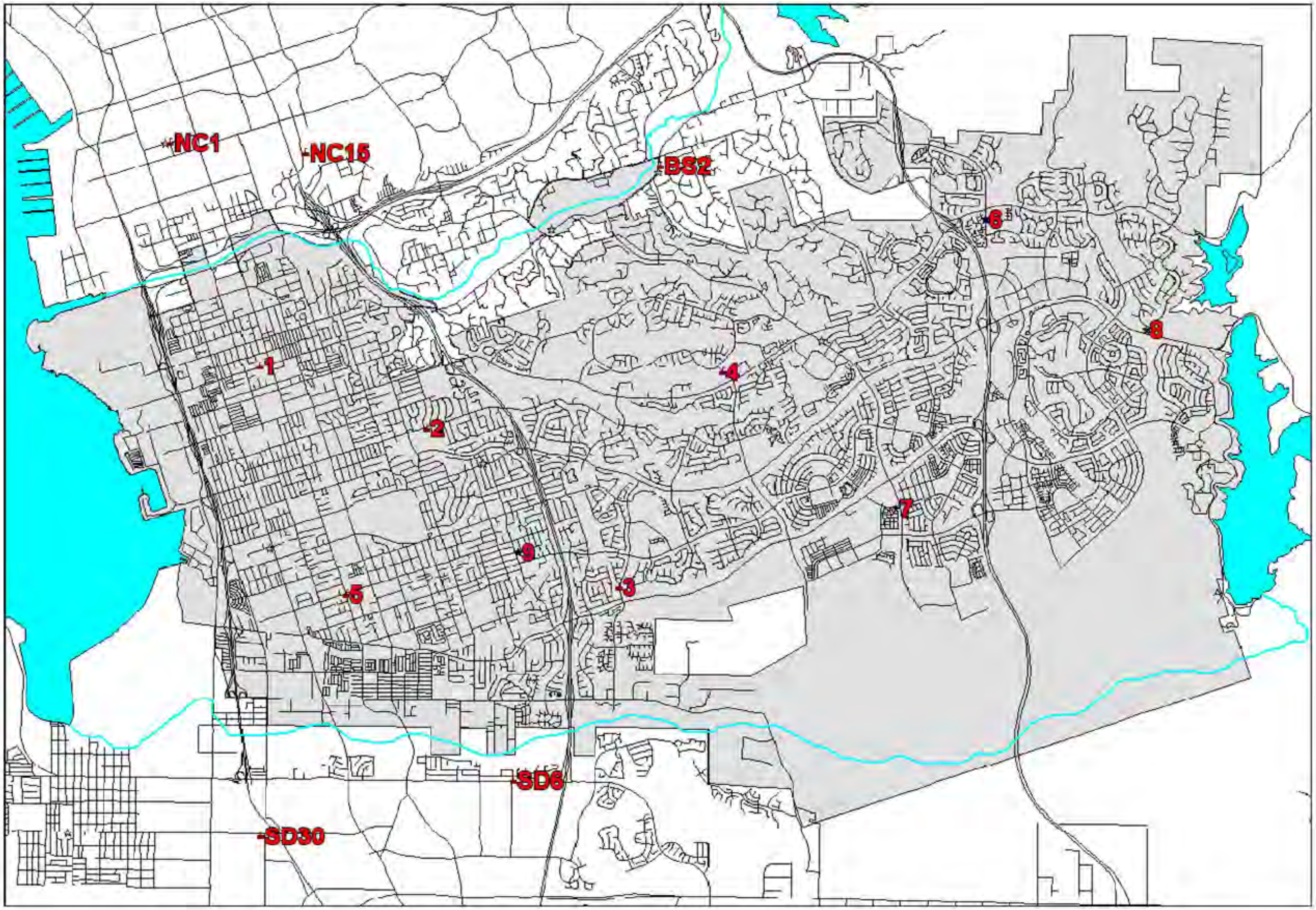
The department had been operating with engine companies in eight of the nine locations and a standalone USAR (FS03) at the ninth location. Two stations (FS01 and FS07) house ladder companies with the engine companies. Operations battalion chiefs also run out these two fire stations. Current staffing is:

Engines	8 stations	3 personnel per unit	24 personnel total
Trucks	2 stations	4 personnel per unit	8 personnel total
USAR	1 station	4 personnel per unit	4 personnel total
BC	2 stations	1 person per unit	2 personnel total
		On-duty strength	38 personnel total

Chula Vista Fire Department staffs at a minimum/maximum on a daily basis. No extra positions exist on any shift for vacation, sick leave, workers' compensation, or special assignment coverage. Staffing is maintained each day through the use of "backfill" hiring to maintain the minimum on-duty strength listed above.

.

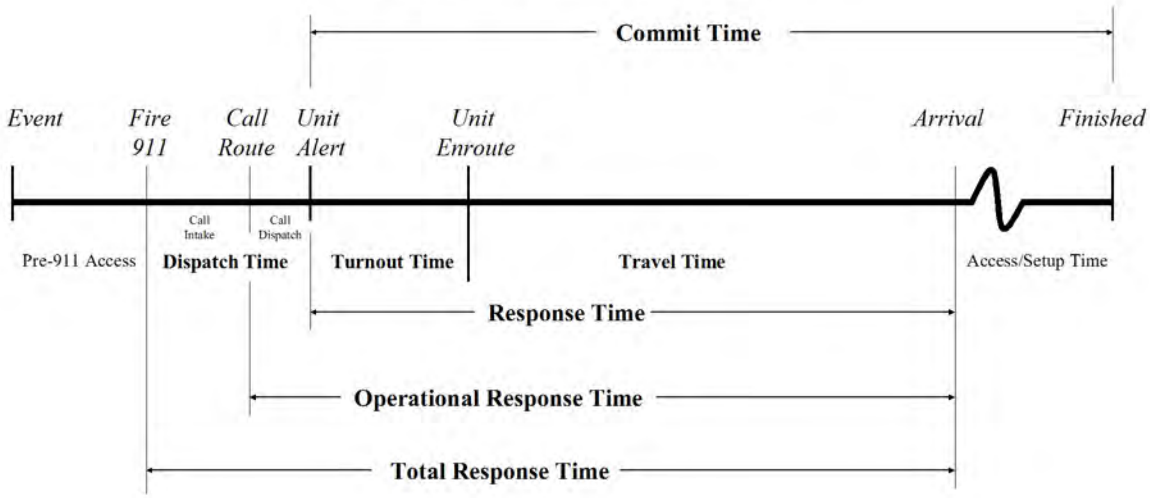
Figure 1: Current Station Locations



Basic Concepts/Terms

When analyzing response time, it is important to make sure that the terms are well established as they tend to change from one organization to another. The chart below shows the intervals that will be used in this report.

Figure 2: Response Time Intervals



Three aspects of response time have an impact on all calls regardless of the type or location: dispatch time, turnout time, and travel time.

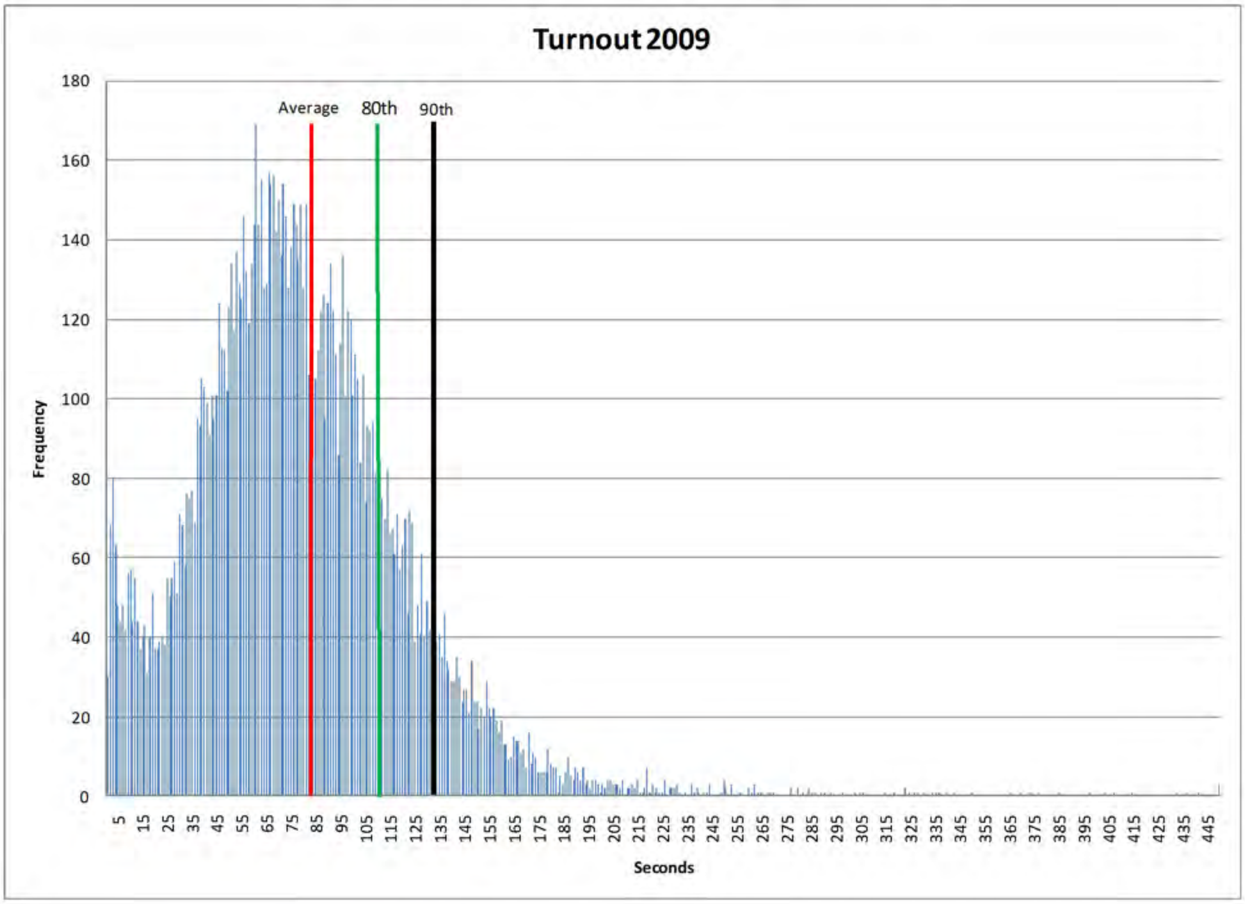
Dispatch Time

Dispatch time for CVFD has two components. The first is the Fire 9-1-1 answering point where the call taker gets the basic information to determine which emergency services are needed; this is the call intake component. The second component is the fire department-specific dispatch function. The point in time where the call intake component ends and the specific dispatch function starts is when call information is sent to the fire dispatcher (route time). For discussion on this objective, the call route time component will be used as this is the historical data point that has been utilized to report performance. This interval is approximately 16 seconds, on average, and is not a performance issue in this study. No technology or procedure exists that will decrease this value to a point where it would make a noticeable difference in the overall performance. Within the core emergency call category, 50 percent of calls are dispatched within one minute and 80 percent within 1.5 minutes for total dispatch time.

Turnout Time

The turnout time interval starts when the units are alerted of the call and ends at the point when the unit begins to travel to the emergency. The average for core emergencies in 2009 was 1:20 (1 minute 20 seconds) (see Figure 3). The 80th percentile was at 1:50; the 90th percentile was at 2:11.

Figure 3: Turnout Times – Frequency Distribution



Travel Time

Travel time is the critical tool in analysis of fire station locations and system performance. Travel time can be measured, calculated, and modeled with greater certainty than any other performance factor. While time of day and day of week will have impacts on travel time, these can be assessed and factored when necessary. Several methods of estimating travel time have been employed in the fire service over the years. Most urban and metro departments use 30 to

35 miles per hour as an average travel speed. Modeling for this project used speed limits on various roads that were then adjusted to actual performance. This is covered in more detail in Task 1 - Validate New Deccan Model.

Generally speaking, deployment is measured with three concepts: **distribution** (what and where), **concentration** (how much), and **reliability** (how well).

Distribution

A successful distribution network means that the system is capable of providing a resource to the scene of an emergency with the correct equipment, apparatus, and staffing to complete the following:

- Assessment of the situation
- Establishment of a plan of action capable of mitigating the emergency
- Request for appropriate resources (if needed)
- Intervention to stop/impede the escalation of the emergency

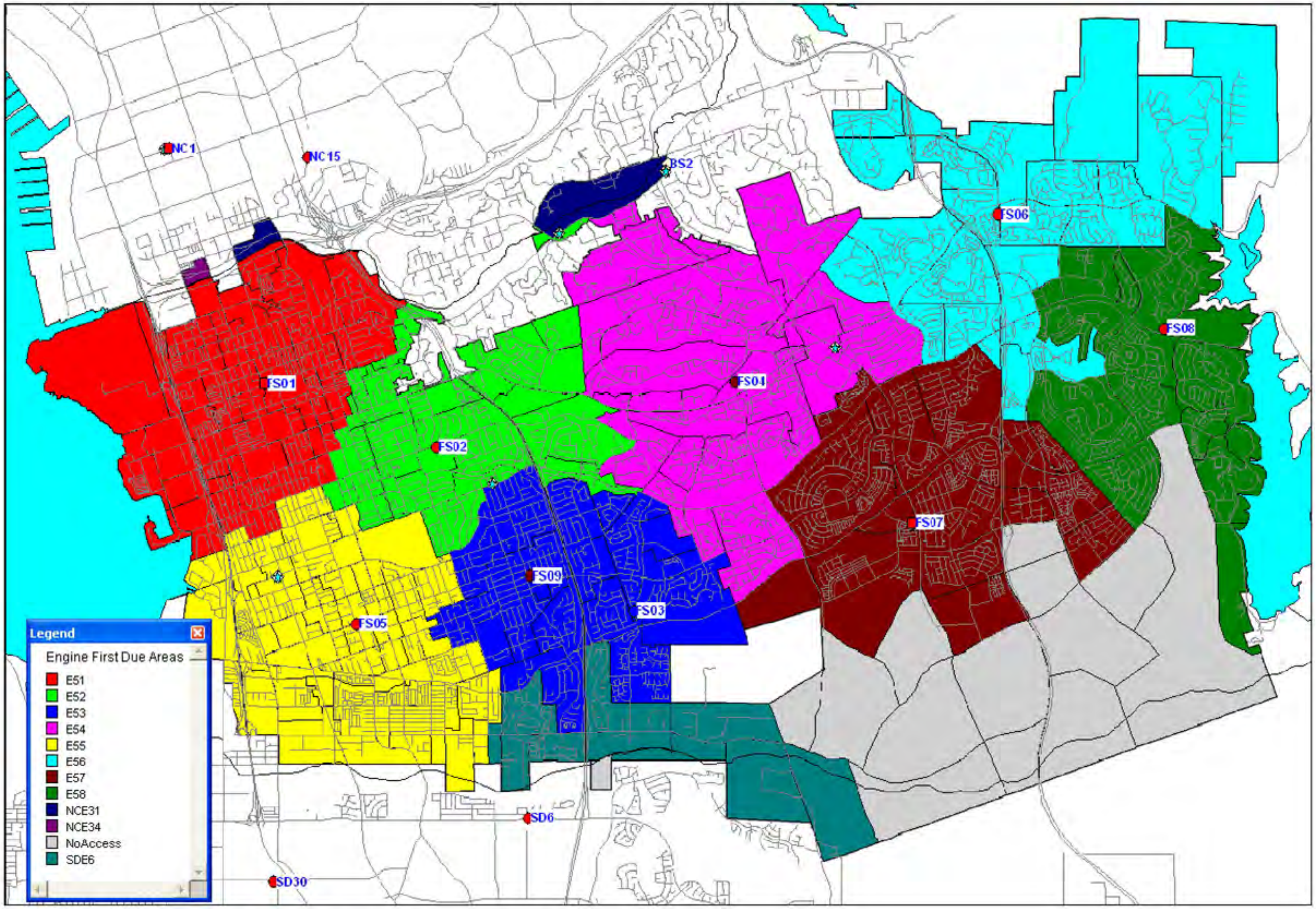
Primary distribution within CVFD is accomplished with the engine companies. As shown on the department's first due map (Figure 4), each engine company covers a primary portion of the city. The same is true for specialized resources such as truck companies and battalion chiefs. The City currently has two of each, housed at Station 1 and Station 7. The coverage areas are shown in Figure 5 for truck coverage and Figure 6 for battalion chief coverage.

Distribution of Resources

The current delivery system has evolved over time, reacting to growth, calls for services, opportunities for land, and availability of funds. This was accomplished with logic, experience, and years of understanding what it takes to deliver service to the homes and on the streets of Chula Vista.

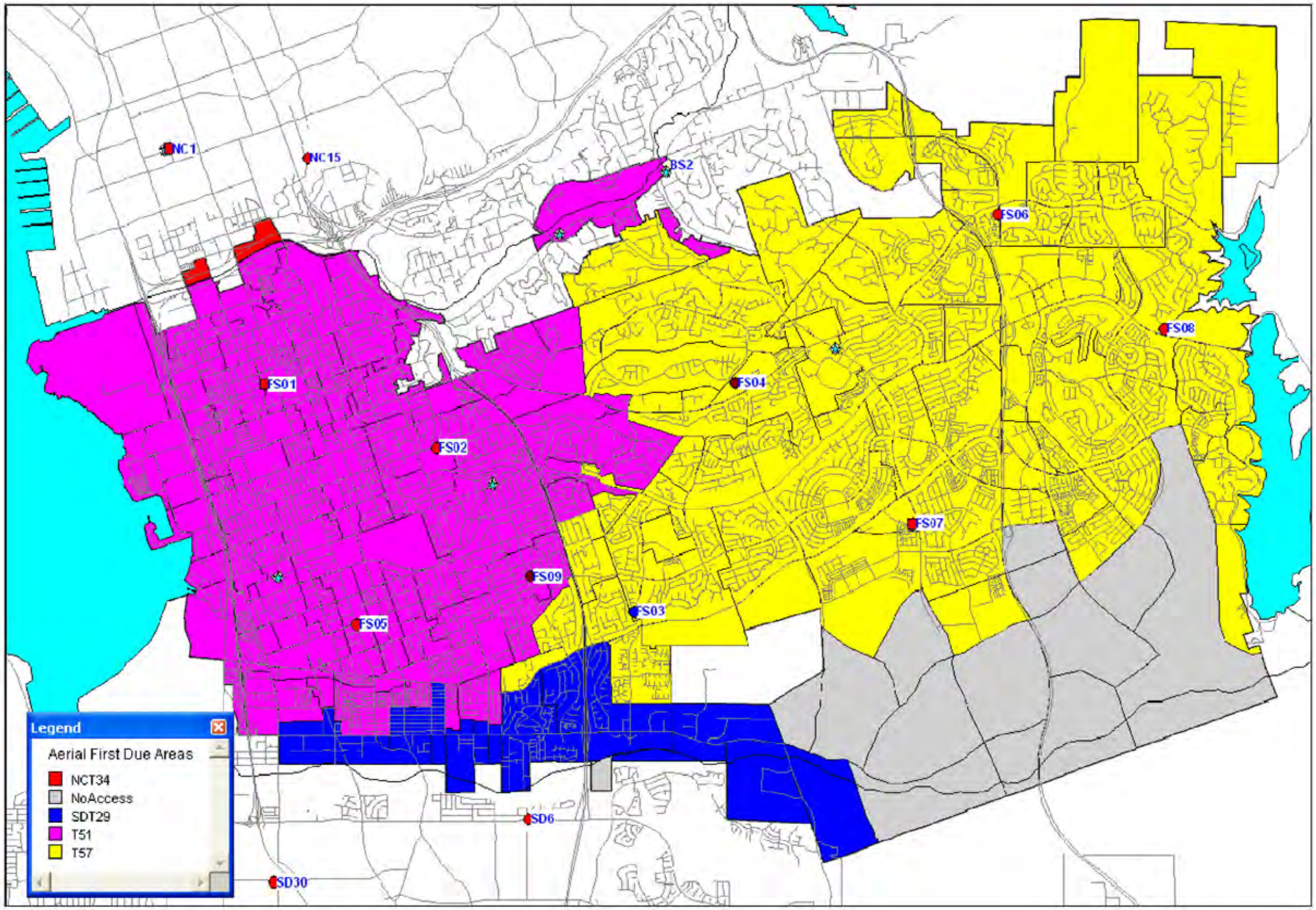
The primary performance measure that drives the distribution/location of fire stations for the CVFD is travel time. The first measure is the arrival time of the first unit to the scene of the emergency. Using a performance measure of having the first unit arrive within four minutes travel time (begins when unit is enroute to the call and ends with the arrival of the unit at the scene of the emergency); the current level of performance is at the 73rd percentile. At five minutes travel time, the performance is at the 89^{th} percentile. Figure 7 shows the current travel time graphic for 2009. It should be noted that this graphic (Figure 7) has a configuration with the USAR at FS03 and Engine 3 located at FS09 as Engine 9.

Figure 4: Fire Due Engine Coverage



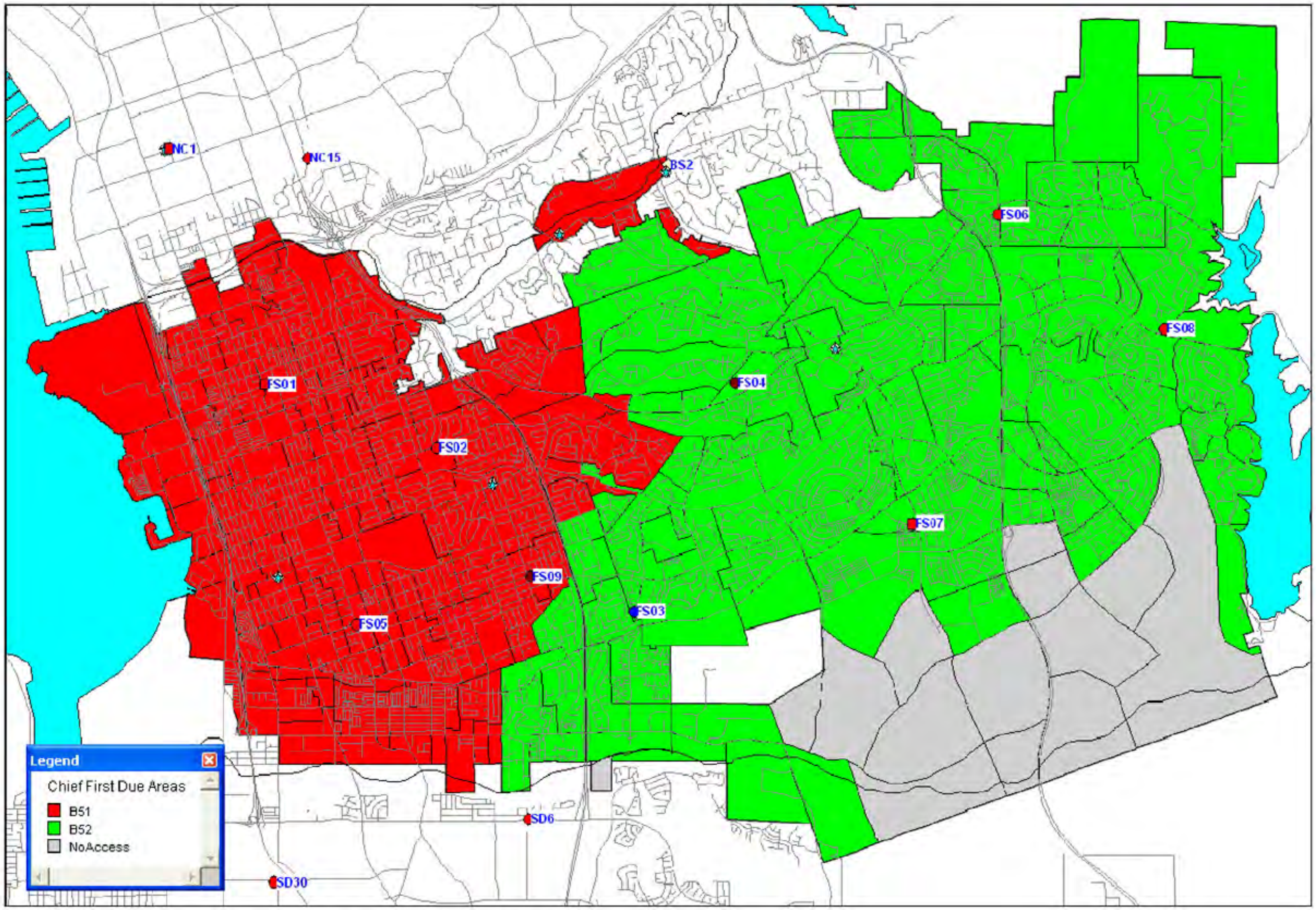
First Due Engine - 8 engines

Figure 5: First Due Truck Coverage



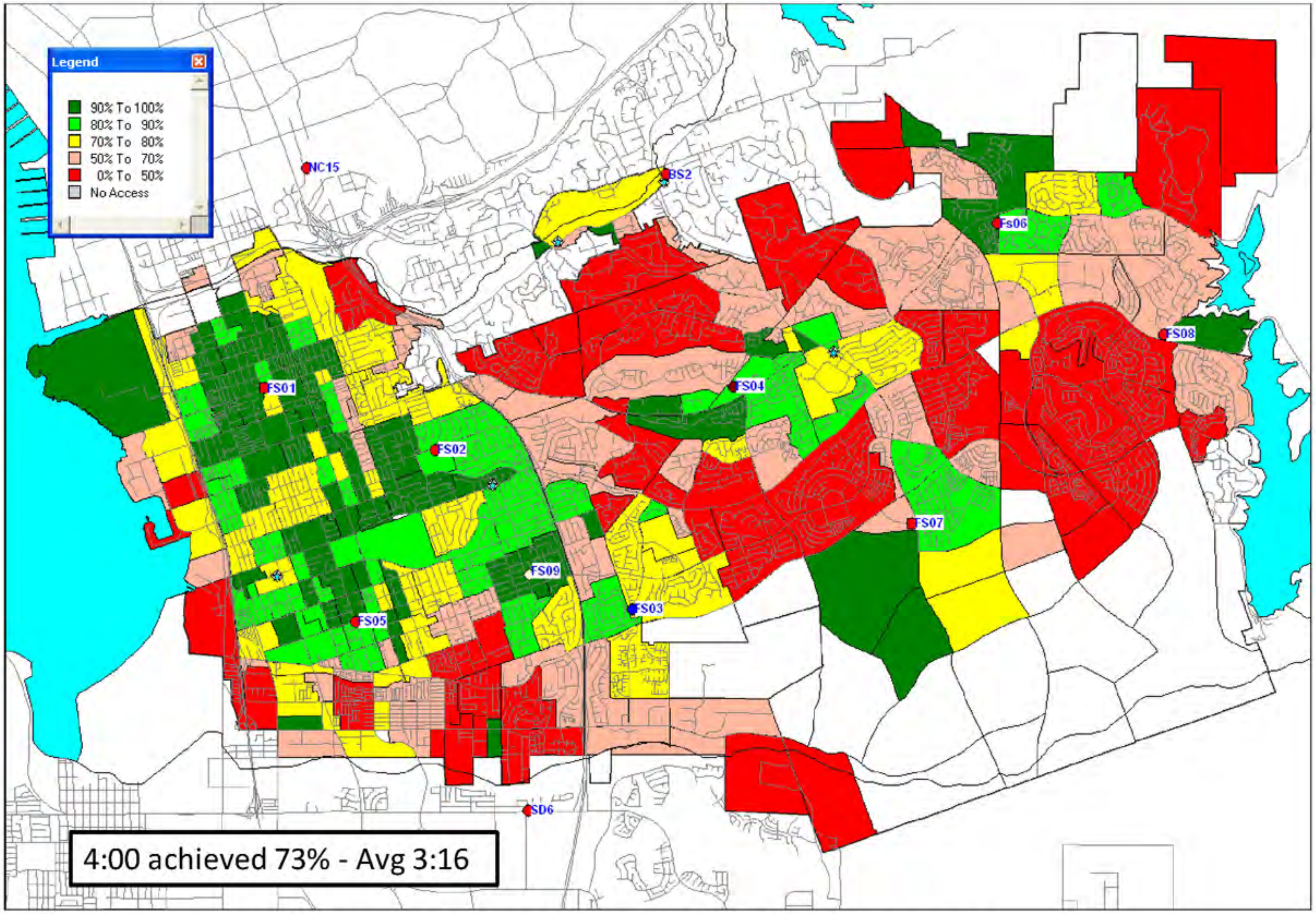
First Due Truck - 9 stations/ 2 Trucks

Figure 6: Fire Due Battalion Chief



First Due Battalion Chief - 9 stations/ 2 Trucks

Figure 7: Travel Time, 2009 Core Emergencies



First Unit Travel (Enroute to Onscene) – Actual 2009 Core Emergencies

Concentration

A successful concentration network means that the system is capable of providing a resource to the scene of an emergency with the correct equipment/apparatus and staffing to complete the following:

- Stop the emergency from continuing to escalate
- Provide for the safety and security of citizens and emergency workers
- Complete all critical tasks in a timely manner
- Provide for incident management

Concentration is achieved in two ways: First is the spacing of the fire stations; second is in the staffing/equipment deployed in each fire station. The spacing of fire stations was a primary concern in the distribution of resources but plays a role in the concentration of resources as well. In Chula Vista, fire stations in the west side are spaced more closely than those on the east side. This has a particular impact on the timing of the second arriving engine

While several measures of performance are available to examine the concentration of resources, two are particularly good. These are IAF (Initial Attack Force) and EFF (Effective Fire Force). A critical task analysis (CTA) was conducted to identify/validate needed resource distribution and staffing patterns. It was determined that a moderate risk fire response needs to consist of three engine companies, one truck company, and one battalion chief. A total of 14 personnel are needed to complete an EFF. (The CTA is detailed in Task 3 of this report.) Additionally, it was determined that four personnel are needed for the IAF. Two are used to enter the IDLH (Immediately Dangerous to Life and Health) atmosphere and two remain outside of the IDLH as a rescue team in the event of a problem with the entry crew. This action is required by OSHA.

> *OSHA states that "once firefighters begin the interior attack on an interior structural fire, the atmosphere is assumed to be IDLH and paragraph **29 CFR 1910.134(g)(4)** [two-in/two-out] applies." OSHA defines interior structural fire fighting "as the physical activity of fire suppression, rescue or both inside of buildings or enclosed structures which are involved in a fire situation beyond the incipient stage." OSHA further defines an incipient stage fire in **29 CFR 1910.155(c)(26)** as a "fire which is in the initial or beginning stage and which can be controlled or extinguished by portable fire extinguishers, Class II standpipe or small hose systems without the need for protective clothing or breathing apparatus." Any structural fire beyond incipient stage is considered to be an IDLH atmosphere by OSHA.*

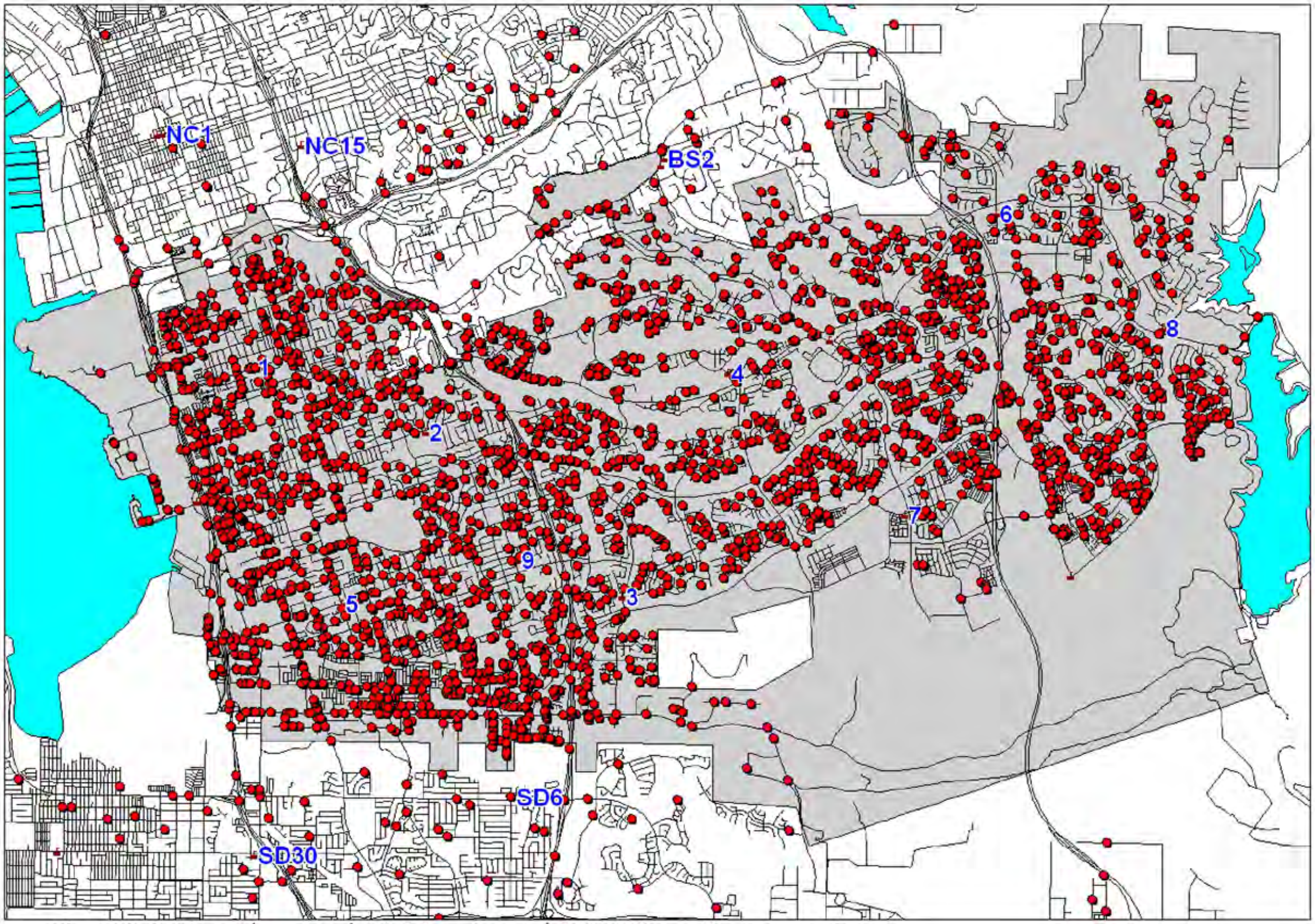
It is important that decision makers understand the nature of the deployment analysis and the tools that are used in this analysis. Two of these tools are covered briefly here for the purpose of common understanding.

Analysis Principles - *Fractile Performance* and *Diminishing Return of Resources.*

Fractile performance is simply a way of stating that all performance is at or below the level indicated. This is also called percentile or percent rank by some analysts. It does not speak to the values directly, except to say that they are above or below the point. In order to increase the performance from the 80th percentile to the 90th percentile, an impact must be made on some or all of the calls for service above the 80th percentile, and half of them will need to be affected in a manner that brings them below the 80th percentile value. The resources needed to accomplish this improvement will be greater as the performance values increase. This is due to the Diminishing Return of Resources in the delivery system.

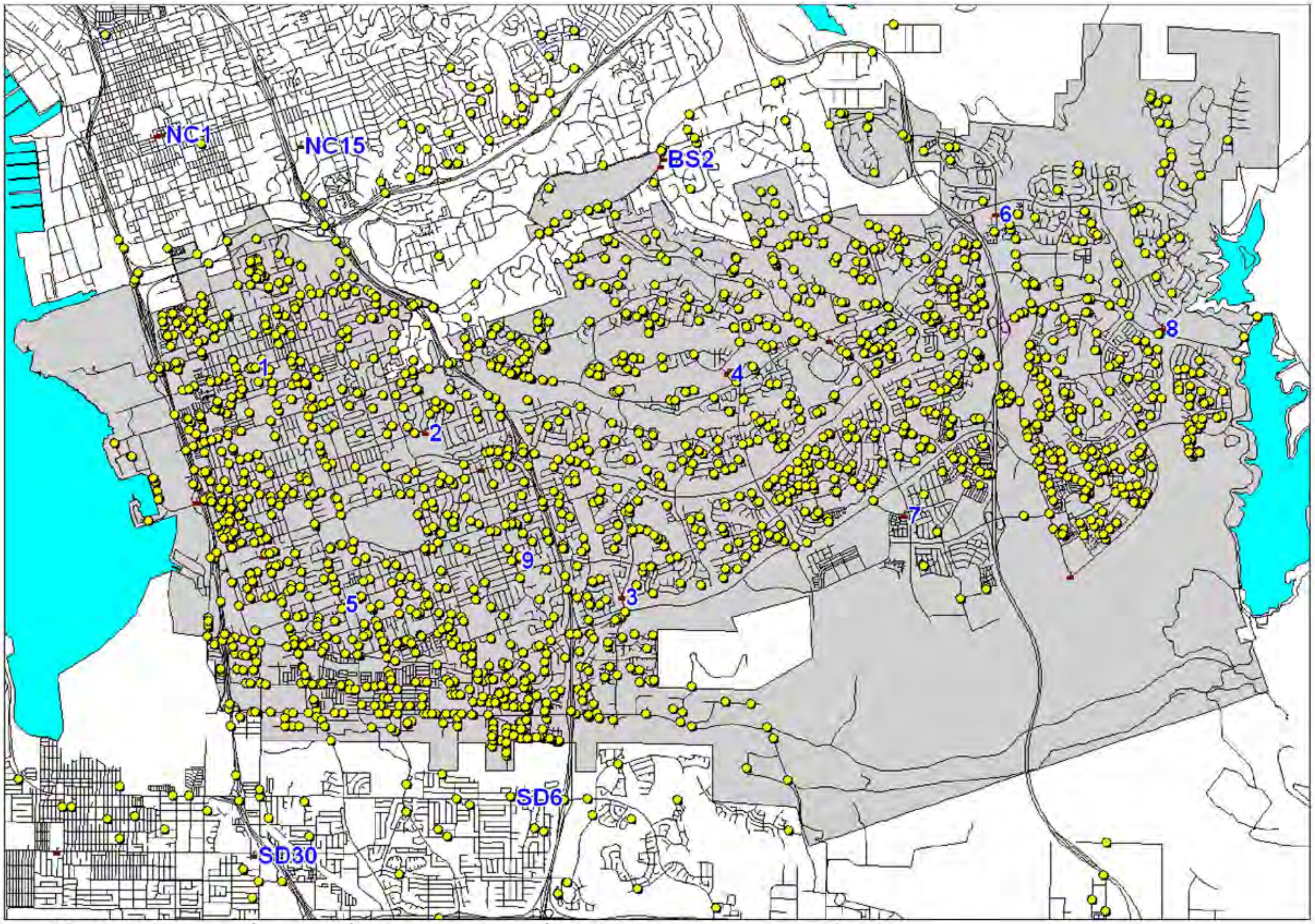
Diminishing Return of Resources means that a resource being added to or subtracted from the system will not always create the same amount of change in the performance. For example, in graphics that follow they show the locations of calls for service that exceeded the four-minute (Figure 8), five-minute (Figure 9), six-minute (Figure 10), and seven-minute (Figure 11) travel time performance levels. It is clearly evident that the remaining calls in each layer are relatively evenly distributed across the entire delivery system. Again, half of the remaining calls would need to be impacted to achieve a movement from the 80th to 90th percentile. Adding a resource to an areas which is totally un-served within the standards will achieve a maximum impact in that area. However, if the area has few calls or a poor road network, it will not produce as much improvement in the overall performance as areas with high call volume and efficient road networks. In addition, as the desired performance level moves from the 80th percentile to the 90th percentile, resources must address fewer and fewer calls for service over the entire areas served as shown in the previous maps of travel time. For this reason, the impact of each new resource is diminished by the lack of calls that it can have an effect on. As the 90th percentile is approached and passed, the rate of return on single new resources is almost beyond measure.

Figure 8: Call Exceeding Four Minutes, 2009 Core Emergencies



First Unit Travel exceeds 4:00 – Actual 2009 Core Emergencies

Figure 9: Call Exceeding Five Minutes, 2009 Core Emergencies



First Unit Travel exceeds 5:00 – Actual 2009 Core Emergencies

Figure 10: Call Exceeding Six Minutes, 2009 Core Emergencies

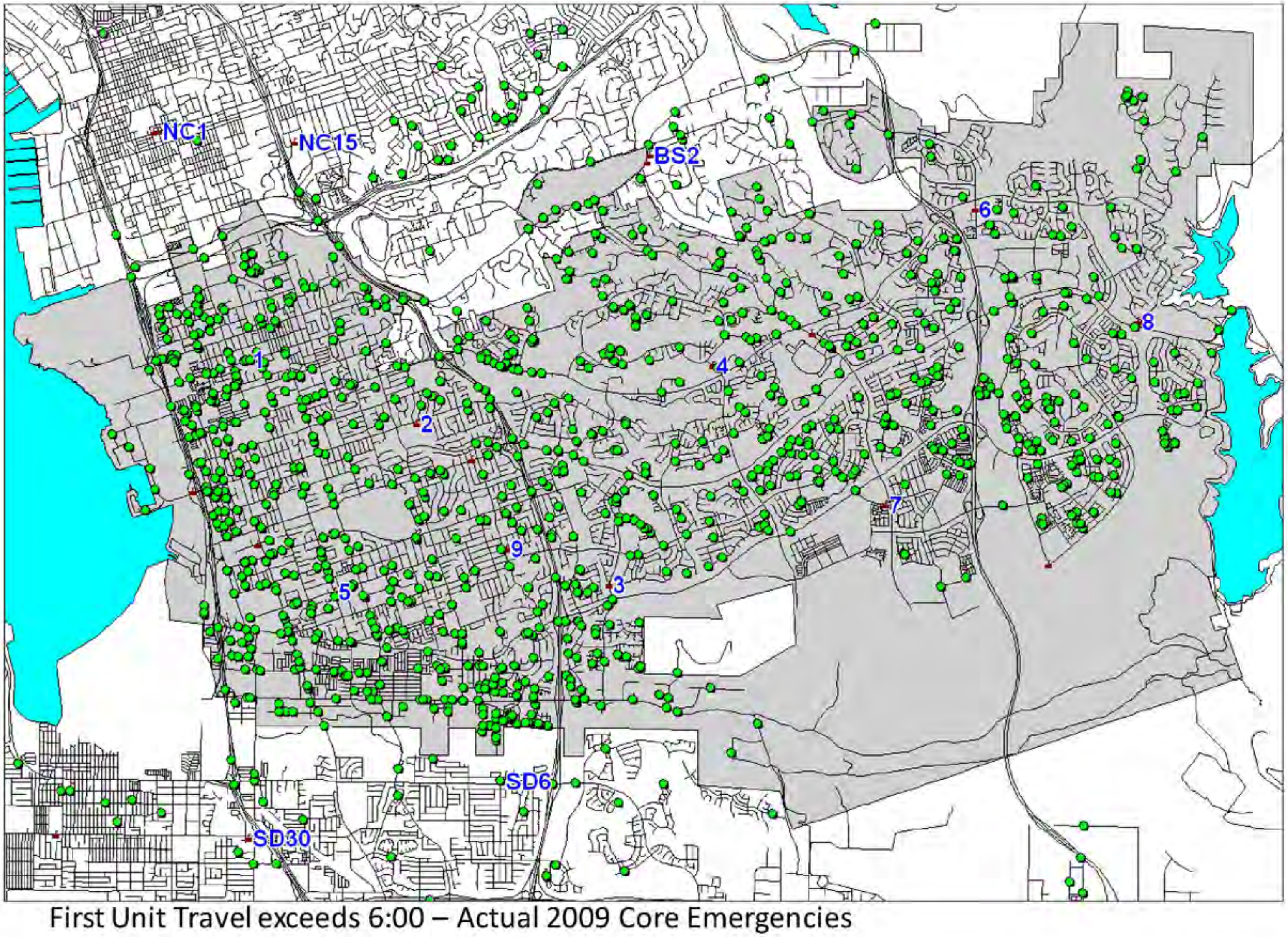
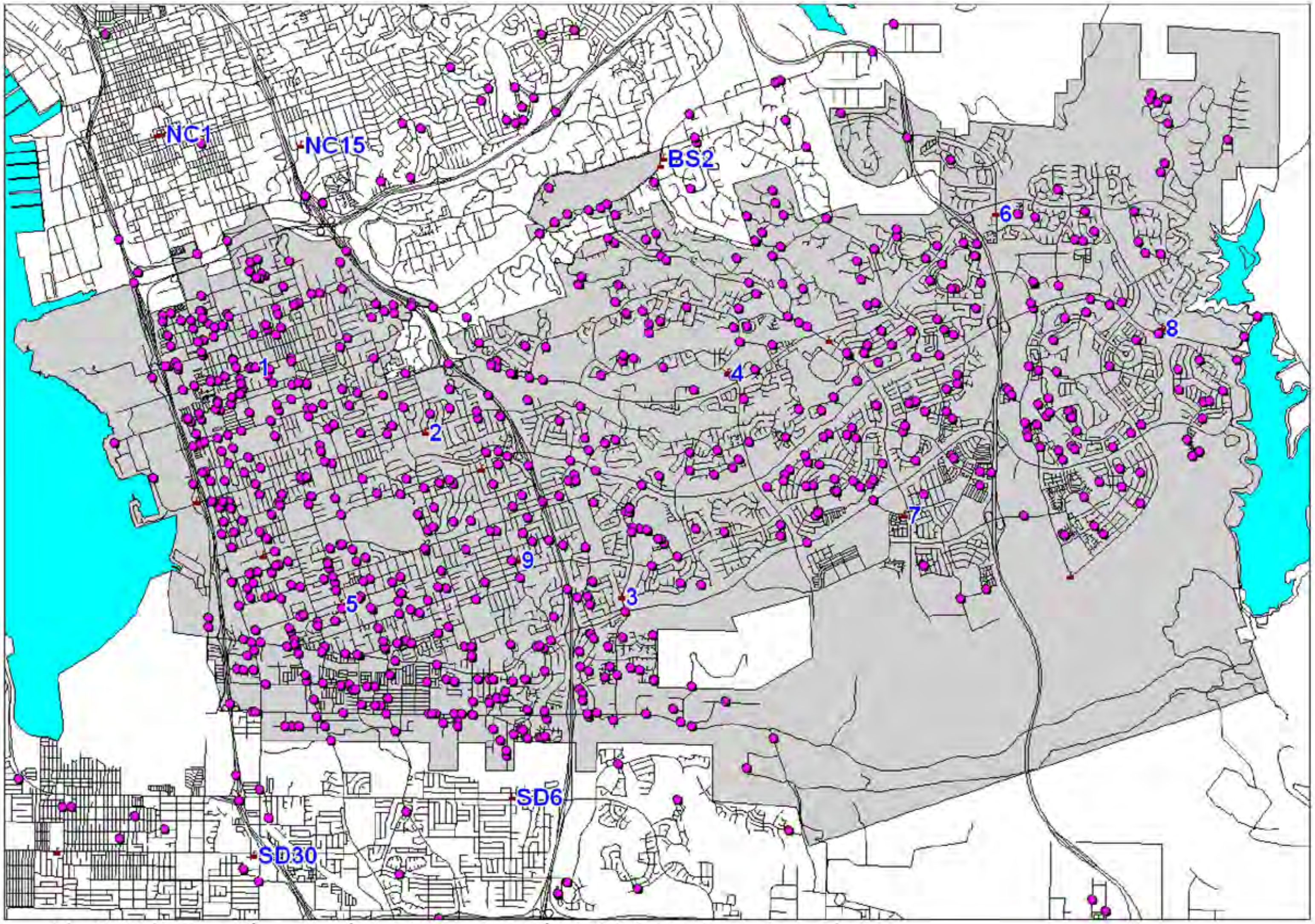


Figure 11: Call Exceeding Seven Minutes, 2009 Core Emergencies



First Unit Travel exceeds 7:00 – Actual 2009 Core Emergencies

Concentration of Assets

For core emergencies (2009), an Effective Fire Force of three engines, one truck, and one battalion chief was achieved within 8:00 of travel time 82 percent of the time with an average of 6:15 (Figure 12). The average arrival time for the second engine was 1:45 behind the first; and for the third engine, 5:21.

EFF has two driving factors. First, is the placement of specialty units, such as the truck and BC, and second is in the concentration of engine companies needed to achieve the level of service desired. As indicated in the Standards of Cover (see Appendix A: Standards of Cover), distribution and concentration push and pull on one another to achieve a balance. Stations with staffing of less than four personnel (six of the current eight) must rely on additional resources from other fire stations to achieve the IAF as well as the EFF. IAF is achieved immediately with four or more personnel arriving on scene initially. FS01 and FS07 have this level of staffing when both units are in quarters at the time of the alarm.

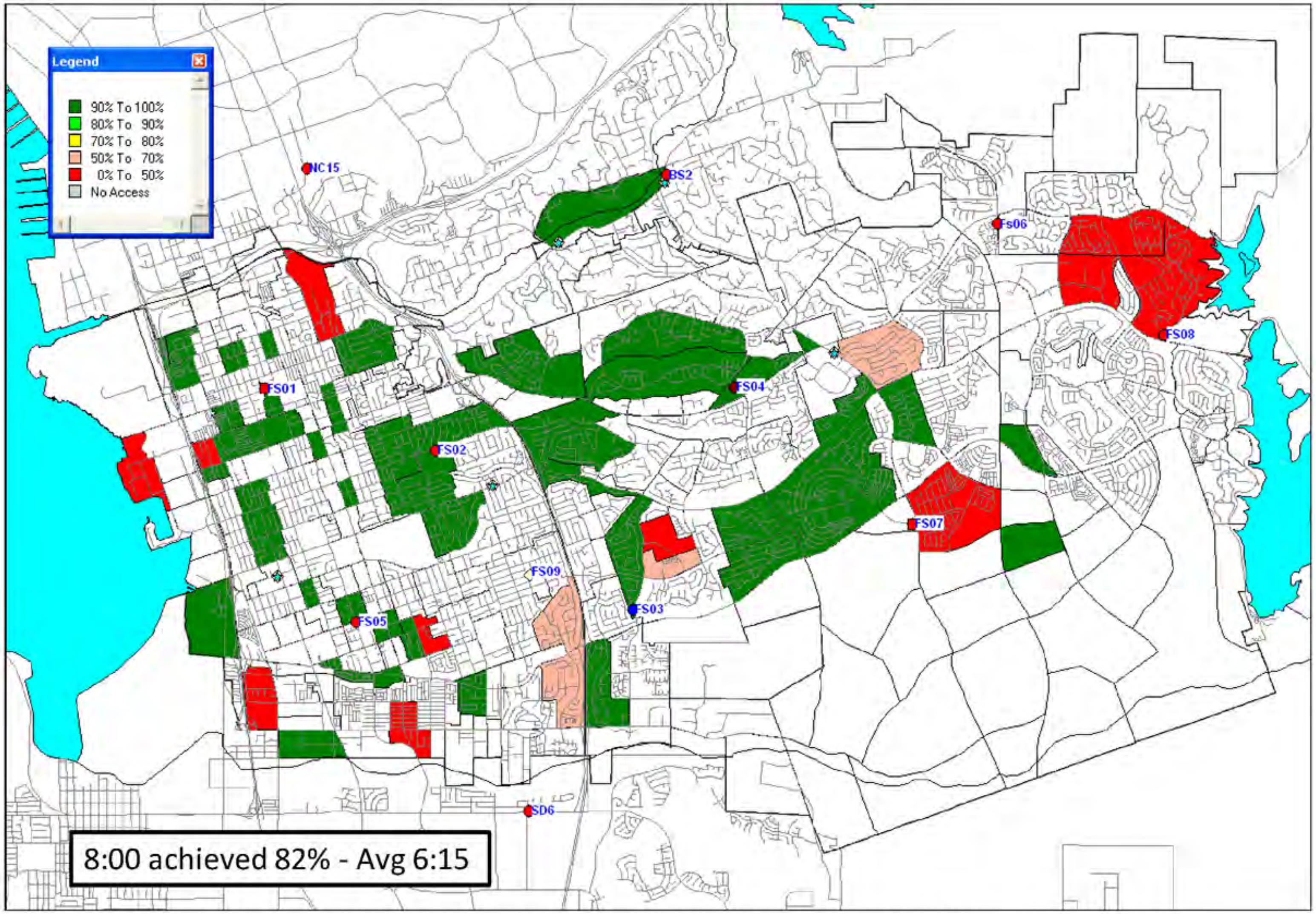
For core emergencies (2009), an Initial Attack Force of four personnel and one engine was achieved within 7:00 from Call Route/Assign (less than 30 seconds before dispatch) 64 percent of the time with an average of 7:41.

These current performance levels are achieved with fire station spacing of approximately three to four miles between stations on the east side. This is the current distribution system. Increasing the performance level will require station spacing to be less than the current distance or an increase in unit staffing to four personnel.

A complete summary of the 2009 performance measures for core emergencies is shown in Figure 13.

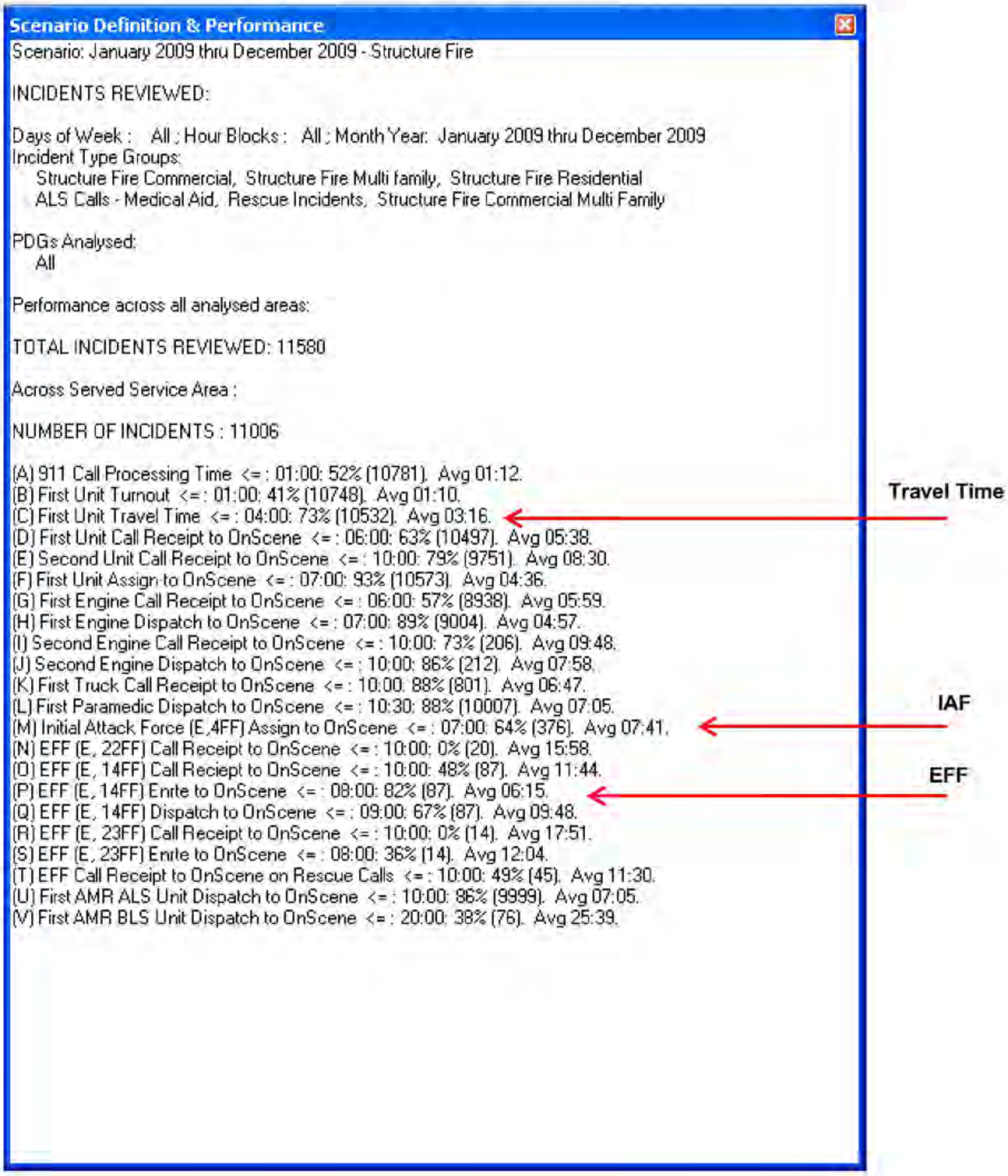
.

Figure 12: EFF for 2009 Core Emergencies



EFF (14 FF, 1 E) – Travel Time @ 8:00 - Actual 2009 Core Emergencies

Figure 13: Core Emergency Summary


Scenario Definition & Performance

Scenario: January 2009 thru December 2009 - Structure Fire

INCIDENTS REVIEWED:

Days of Week : All ; Hour Blocks : All ; Month Year: January 2009 thru December 2009
Incident Type Groups:
Structure Fire Commercial, Structure Fire Multi family, Structure Fire Residential
ALS Calls - Medical Aid, Rescue Incidents, Structure Fire Commercial Multi Family

PDGs Analysed:
All

Performance across all analysed areas:

TOTAL INCIDENTS REVIEWED: 11580

Across Served Service Area :

NUMBER OF INCIDENTS : 11006

(A) 911 Call Processing Time <= : 01:00: 52% (10781). Avg 01:12.
(B) First Unit Turnout <= : 01:00: 41% (10748). Avg 01:10.
(C) First Unit Travel Time <= : 04:00: 73% (10532). Avg 03:16.
(D) First Unit Call Receipt to OnScene <= : 06:00: 63% (10497). Avg 05:38.
(E) Second Unit Call Receipt to OnScene <= : 10:00: 79% (9751). Avg 08:30.
(F) First Unit Assign to OnScene <= : 07:00: 93% (10573). Avg 04:36.
(G) First Engine Call Receipt to OnScene <= : 06:00: 57% (8938). Avg 05:59.
(H) First Engine Dispatch to OnScene <= : 07:00: 89% (9004). Avg 04:57.
(I) Second Engine Call Receipt to OnScene <= : 10:00: 73% (206). Avg 09:48.
(J) Second Engine Dispatch to OnScene <= : 10:00: 86% (212). Avg 07:58.
(K) First Truck Call Receipt to OnScene <= : 10:00: 88% (801). Avg 06:47.
(L) First Paramedic Dispatch to OnScene <= : 10:30: 88% (10007). Avg 07:05.
(M) Initial Attack Force (E,4FF) Assign to OnScene <= : 07:00: 64% (376). Avg 07:41.
(N) EFF (E, 22FF) Call Receipt to OnScene <= : 10:00: 0% (20). Avg 15:58.
(O) EFF (E, 14FF) Call Reciept to OnScene <= : 10:00: 48% (87). Avg 11:44.
(P) EFF (E, 14FF) Enrte to OnScene <= : 08:00: 82% (87). Avg 06:15.
(Q) EFF (E, 14FF) Dispatch to OnScene <= : 09:00: 67% (87). Avg 09:48.
(R) EFF (E, 23FF) Call Receipt to OnScene <= : 10:00: 0% (14). Avg 17:51.
(S) EFF (E, 23FF) Enrte to OnScene <= : 08:00: 36% (14). Avg 12:04.
(T) EFF Call Receipt to OnScene on Rescue Calls <= : 10:00: 49% (45). Avg 11:30.
(U) First AMR ALS Unit Dispatch to OnScene <= : 10:00: 86% (9999). Avg 07:05.
(V) First AMR BLS Unit Dispatch to OnScene <= : 20:00: 38% (76). Avg 25:39.

Task 1 – Validate New Deccan Model

The Deccan Deployment tools are customized software for use in analyzing past performance and predicting future performance based on proposed changes to the delivery system. Appendix B provides a brief overview of the two software programs, their capabilities and their outputs. The first Deccan tool is CadAnalyst. This is a retrospective tool used to review past performance. It is also the basis for the model validation of the second program, ADAM (Apparatus Deployment Analysis Module).

Validation Methods

Validation of the Deccan model has several facets. First is the data set. All calls are geo-coded to give them a place in time and space. This location is then used to assemble information into useful data set. For example, ensuring that the location of the calls is placed in a specific district, development area, and/or first due correctly (Figure 14). The data can then be analyzed at various levels. In this case, it is possible to look at performance for the entire delivery system, a first due area, or for a specific district. Checking the validity of the geo-coding is the first step.

Figure 14: Validation of Geo-Coding

Second on the validation process is to ensure that the road network is both routable and does not have segment breaks. This is accomplished using several utilities (such as one shown in the following figure) that place a red dot at the end of every line segment that is not connected to another segment (Figure 15). If a break in the roadway was present, a red dot would appear in the middle of the roadway. Red dots should only appear at the end of a road (cul-de-sac). Similar utilities are run to make sure the segments are not inappropriately joined or have duplicates.

Figure 15: Validation of Street Network

Next in the process is to visualize the district centroids. Each district has a centroid; this is the point to which routing is calculated. The model bases all of its calculations for performance on this location within the district. It is important that the centroid accurately reflect the district to the best of its ability. Centroids are assigned by the program to be at the geographic center of the district. This is complicated by irregular shapes within districts and by roadway such as freeways or one-way streets that have limited access or conductivity. These must be examined to find the best possible centroid (Figure 16).

Figure 16: Centroid Validation

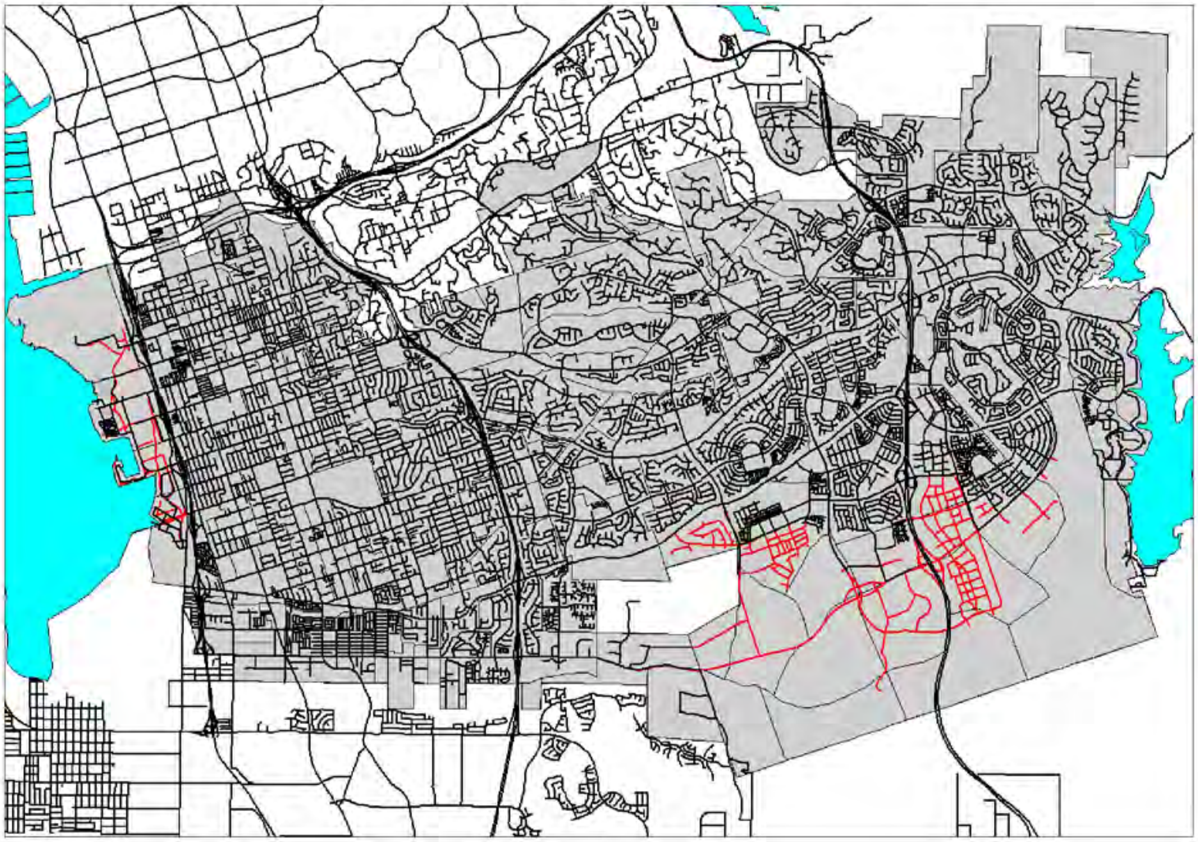
Centroids are shown above in purple/District boundaries in green.

Streets were also validated against aerial photography, where it was available, as shown in the following figure.

Figure 17: Street Validation - Aerial

Newly proposed streets need to be added to the street network. These are taken from the circulation plan available through the city and county. Most of the arterials are in, with the exception of the Otay Ranch area. Streets shown in red on the following figure were added (Figure 18).

Figure 18: New Streets Added for Analysis

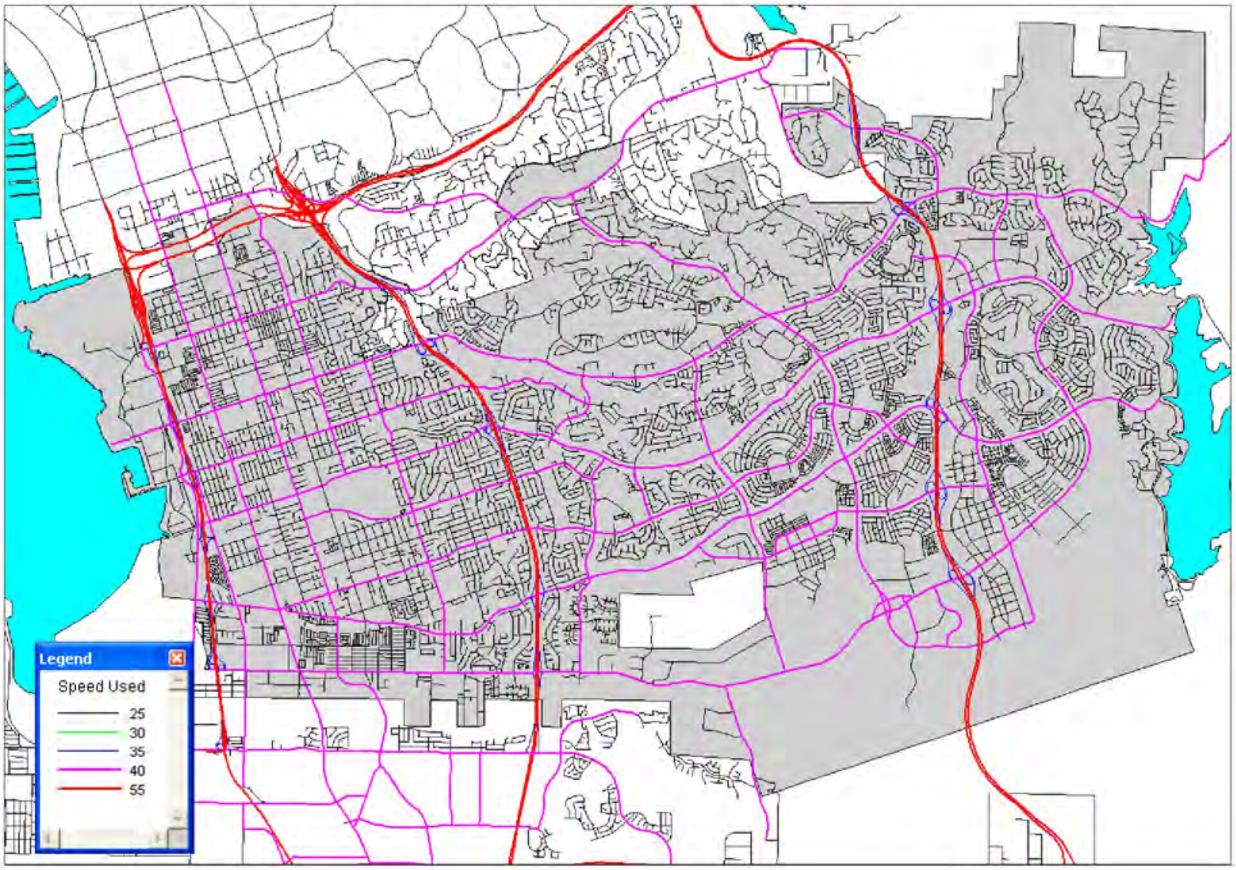


The next process is to check the street speed limits. It was decided to use speed limits rather than an average speed throughout the model. Freeways were calculated at 55 mph, arterials at 40 mph, off-ramps at 35 mph, and residential streets at 25 mph, as shown in Figure 19. The model as it was delivered by Deccan used an average speed limit. Many stations next to freeways and major arterials did not perform as expected.

Model Adjustments

The Deccan model has three factors for adjusting the model to actual performance. These are speed, turnout/reflex time, and the amount of the standard deviation that will be used in the calculation. The system was recalibrated to run on the speed limits and performance more closely match actual response data. In addition to changing the speed at which resources traveled, turnout times were validated in the model as well. The use of the standard deviation was not adjusted from the setting by Deccan.

Figure 19: Street Network Speeds



When validation was complete, modeling runs for most factors on ALS calls were nearly the same as the 2009 data. This is possible because the dataset has over 10,000 calls for service. The datasets for rescue and structure fires are not as large. Rescue had only 91 incidents and structure fires 185 incidents. Rescues tend to happen on the transportation grid and have less volatility in the modeling. Structure fires are more complex (more units responding/more variables). All values are within the 90 percent confidence range for the differences.

Task 2 – Update Data Assumptions

Baseline Assumptions

Current Performance Objectives

The Chula Vista Fire Department has determined that *NFPA 1710* is the appropriate performance standard for planning purposes within the city. The mission of the international nonprofit NFPA, established in 1896, is to reduce the worldwide burden of fire and other hazards on the quality of life by providing and advocating consensus codes and standards, research, training, and education.

NFPA is the world's leading advocate of fire prevention and an authoritative source on public safety; NFPA develops, publishes, and disseminates more than 300 consensus codes and standards intended to minimize the possibility and effects of fire and other risks. It is the standard recognized by the fire service world-wide.

The specific section of *NFPA 1710* that is used regarding deployment is shown below:

5.2.4 Deployment.

5.2.4.1 Initial Arriving Company.

5.2.4.1.1 The fire department's fire suppression resources shall be deployed to provide for the arrival of an engine company within a 240-second travel time to 90 percent of the incidents as established in Chapter 4.

5.2.4.1.2 Personnel assigned to the initial arriving company shall have the capability to implement an initial rapid intervention crew (IRIC).*

5.2.4.2 Initial Full Alarm Assignment Capability.

5.2.4.2.1 The fire department shall have the capability to deploy an initial full alarm assignment within a 480-second travel time to 90 percent of the incidents as established in Chapter 4.

5.2.4.2.2 The initial full alarm assignment to a structure fire in a typical 2000 ft2 (186 m2), two-story single-family dwelling without basement and with no exposures shall provide for the following:*

(1) Establishment of incident command outside of the hazard area for the overall coordination and direction of the initial full alarm assignment with a minimum of one individual dedicated to this task

(2) Establishment of an uninterrupted water supply of a minimum of 400 gpm (1520 L/min) for 30 minutes with supply line(s) maintained by an operator

(3) Establishment of an effective water flow application rate of 300 gpm (1140 L/min) from two handlines, each of which has a minimum flow rate of 100 gpm (380 L/min) with each handline operated by a minimum of two individuals to effectively and safely maintain the line

(4) Provision of one support person for each attack and backup line deployed to provide hydrant hookup and to assist in laying of hose lines, utility control, and forcible entry

(5) Provision of at least one victim search and rescue team with each such team consisting of a minimum of two individuals

(6) Provision of at least one team, consisting of a minimum of two individuals, to raise ground ladders and perform ventilation

(7) If an aerial device is used in operations, one person to function as an aerial operator and maintain primary control of the aerial device at all times

(8) Establishment of an IRIC consisting of a minimum of two properly equipped and trained individuals

Measurements of System Performance

The basic input for this analysis is calls for service or workload.

Workload

The first step in the analysis of system performance is to examine the number and locations of the calls for service. This workload needs to be accurate and defined well enough to allow decision makers to see the value of alternatives relative to service delivery points and the need for additional resources in those locations. The overall workload within the fire department continues to increase. The nature of the calls is changing as well. Medical calls continue to increase and now account for over 80 percent of the call volume in the department. The details are provided in Figure 20.

Figure 20: Calls for Service

	2007		2008		2009	
ALS	11,548	80.4%	10,687	71.9%	10,969	70.0%
BLS	119	0.8%	1,800	12.1%	2,326	14.8%
	11,667	81.2%	12,487	84.0%	13,295	84.9%
Rescue	286	2.0%	120	0.8%	130	0.8%
SFCom	72	0.5%	8	0.1%	-	0.0%
SFComMF	-	0.0%	86	0.6%	169	1.1%
SFMf	117	0.8%	16	0.1%	-	0.0%
SFResd	142	1.0%	113	0.8%	122	0.8%
	331	2.3%	223	1.5%	291	1.9%
Alarm	953	6.6%	923	6.2%	817	5.2%
Bomb	2	0.0%	4	0.0%	1	0.0%
BrushFire	143	1.0%	75	0.5%	53	0.3%
HazMat	212	1.5%	152	1.0%	173	1.1%
NonEmr	260	1.8%	261	1.8%	220	1.4%
OtherEmr	211	1.5%	301	2.0%	340	2.2%
OtherFire	147	1.0%	166	1.1%	193	1.2%
VehFire	156	1.1%	153	1.0%	152	1.0%
	2,084	14.5%	2,035	13.7%	1,949	12.4%
Grand Total	14,368		14,865		15,665	

As is shown in Figure 21, calls for service locations are spread over the entire city in a relatively consistent pattern. When examined by call type, this holds true for medical calls (Figure 22) and fire calls (Figure 23); but rescue calls (Figure 24) tend to be grouped around the transportation network, as would be expected.

Figure 21: Total Workload - All Calls

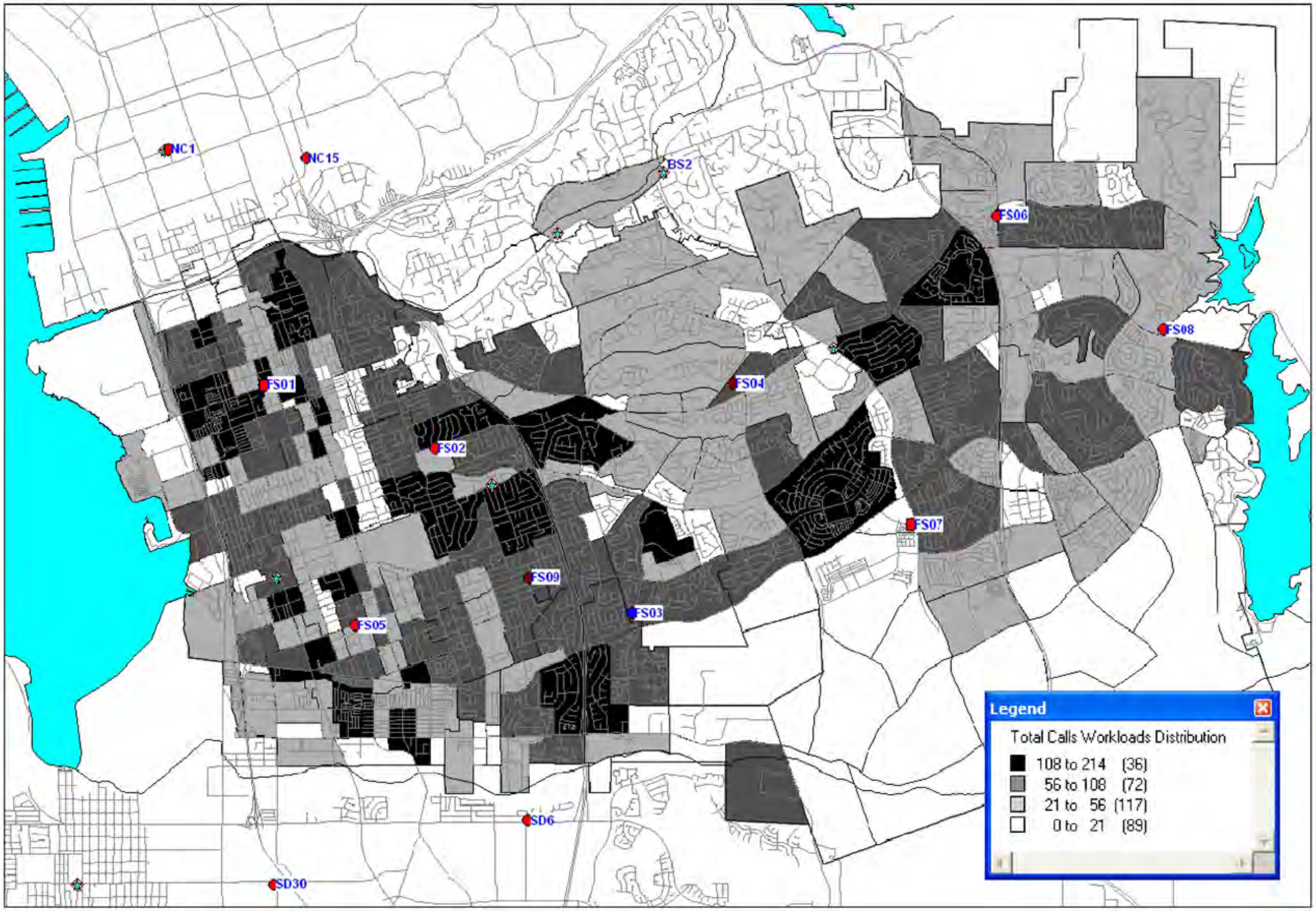


Figure 22: ALS Workload

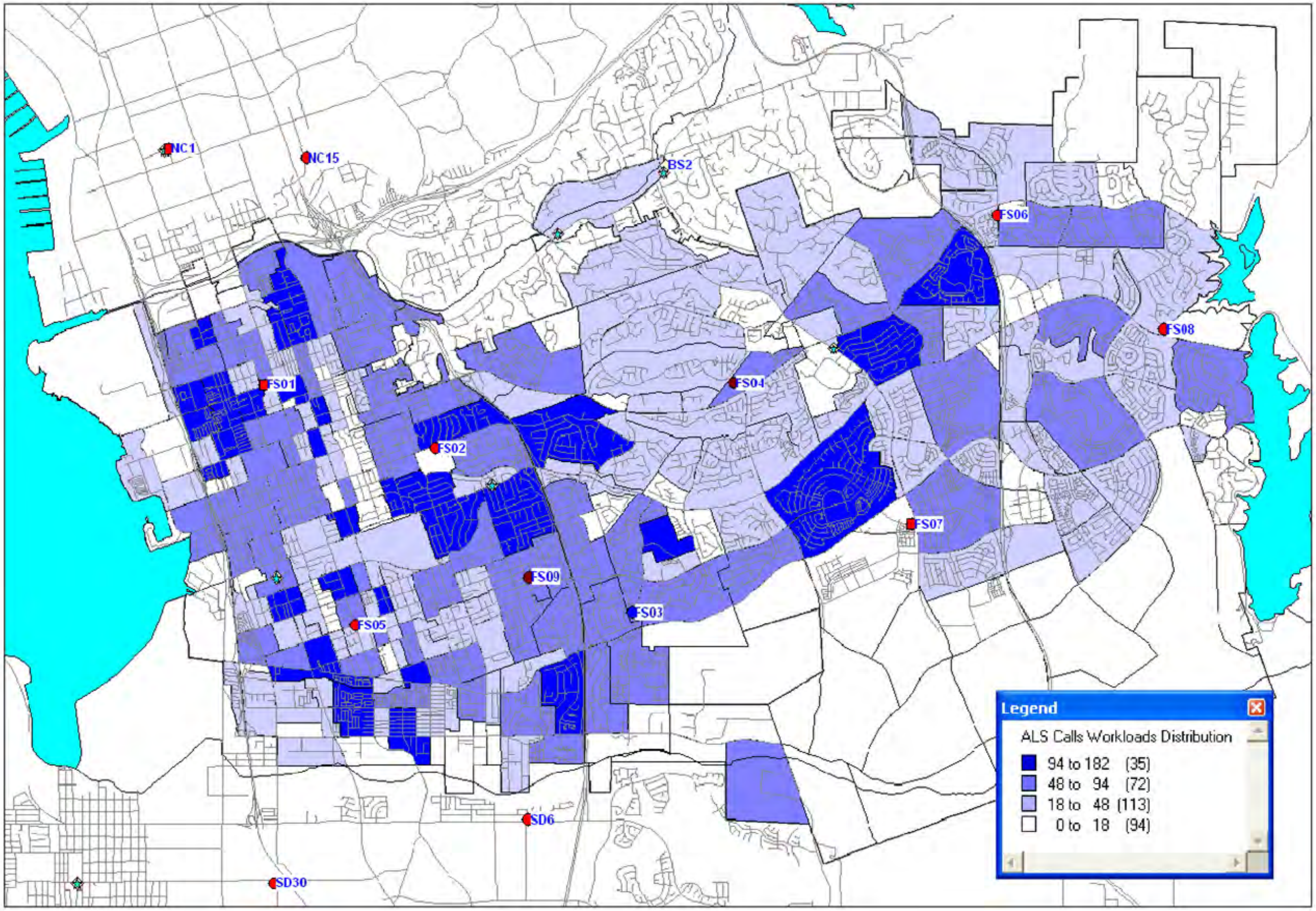


Figure 23: Structure Fire Workload

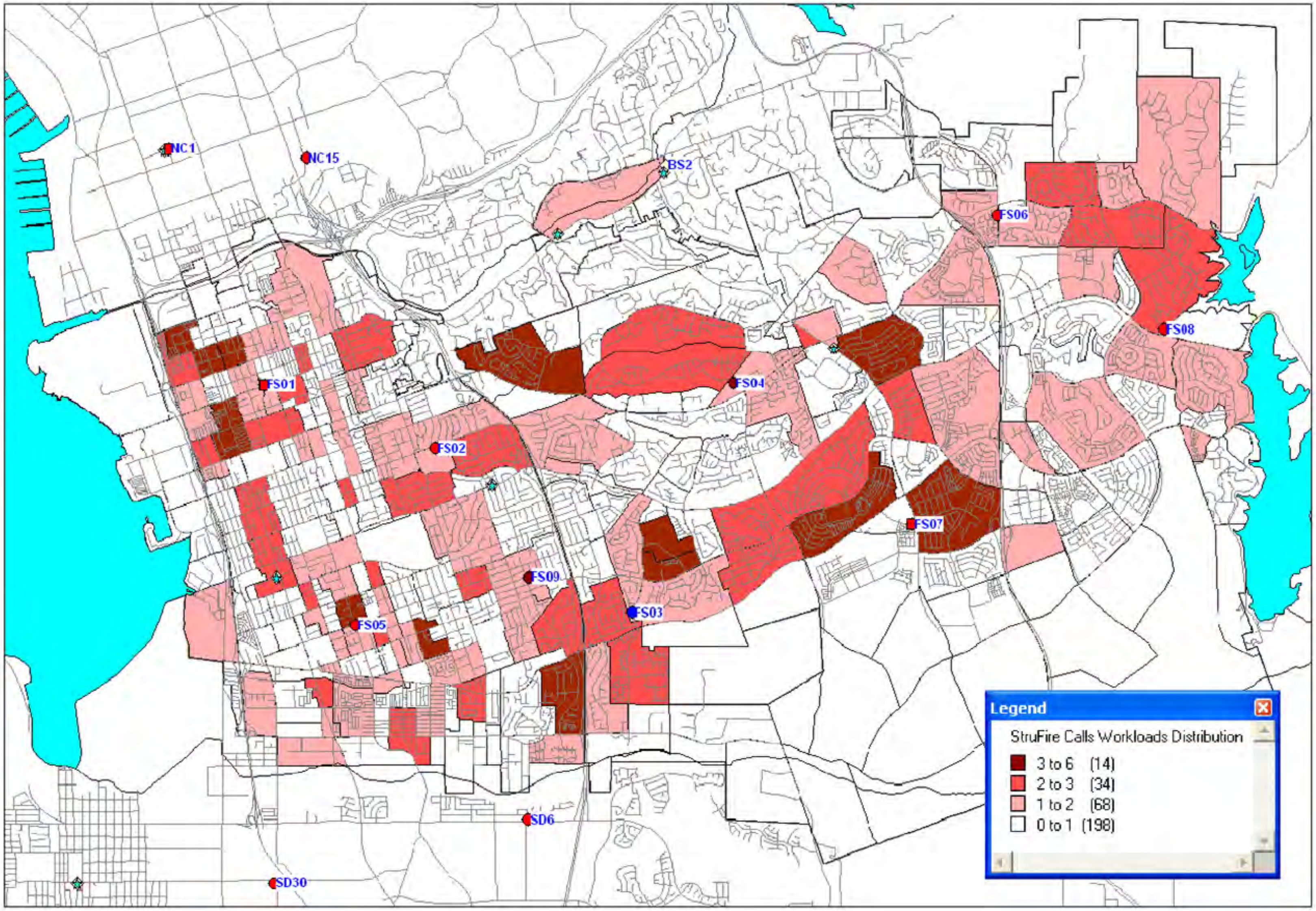
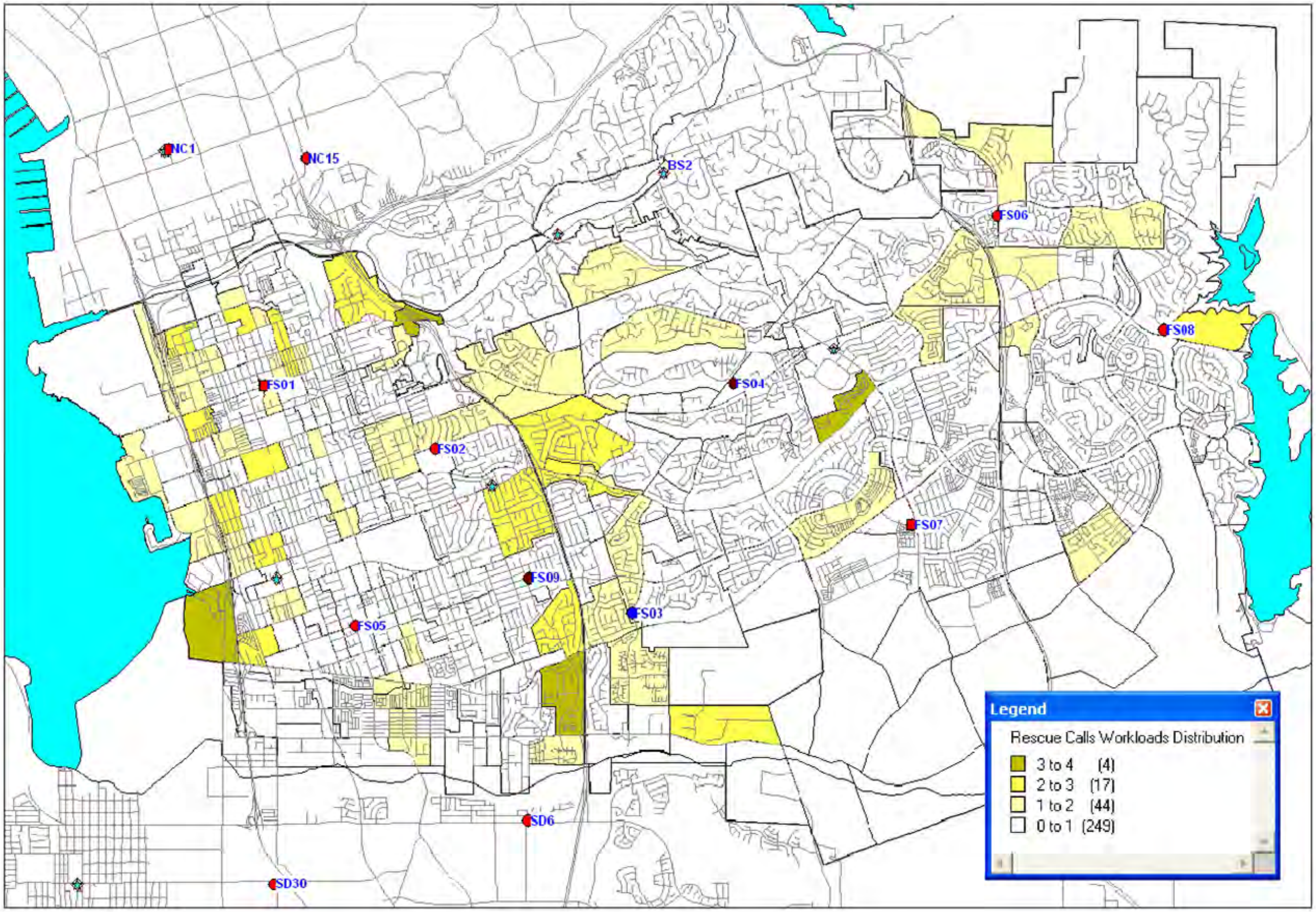


Figure 24: Rescue Workload



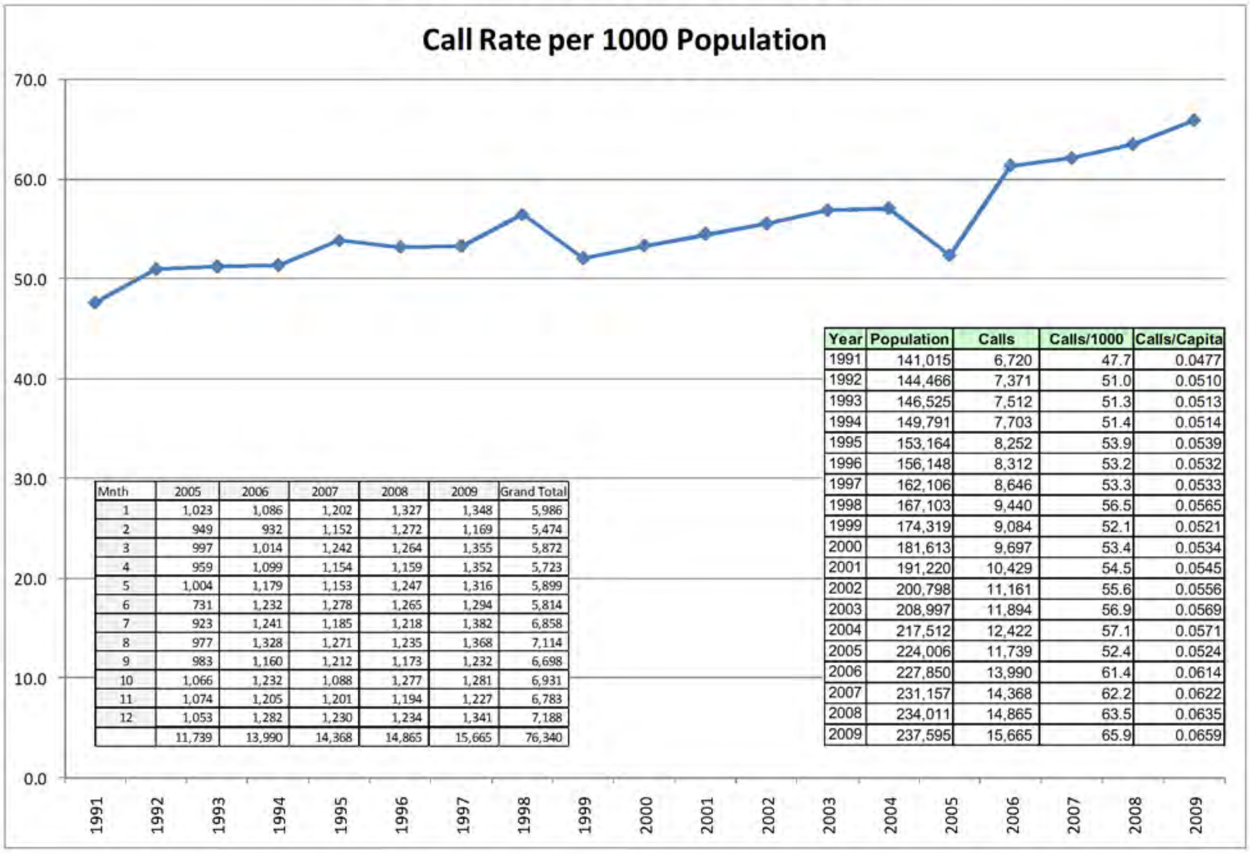
Performance Reliability

Performance reliability is a very good indication of the system's ability to provide service in the real world. Reliability can be assessed at the system level or at the first due level.

System Level Analysis

As shown in Figure 25, the calls for service per 1,000 population served continue to increase. This means that even if growth did not occur, the system will continue to get busier.

Figure 25: Calls per 1,000 Population



Mnth	2005	2006	2007	2008	2009	Grand Total
1	1,023	1,086	1,202	1,327	1,348	5,986
2	949	932	1,152	1,272	1,169	5,474
3	997	1,014	1,242	1,264	1,355	5,872
4	959	1,099	1,154	1,159	1,352	5,723
5	1,004	1,179	1,153	1,247	1,316	5,899
6	731	1,232	1,278	1,265	1,294	5,814
7	923	1,241	1,185	1,218	1,382	6,858
8	977	1,328	1,271	1,235	1,368	7,114
9	983	1,160	1,212	1,173	1,232	6,698
10	1,066	1,232	1,088	1,277	1,281	6,931
11	1,074	1,205	1,201	1,194	1,227	6,783
12	1,053	1,282	1,230	1,234	1,341	7,188
	11,739	13,990	14,368	14,865	15,665	76,340

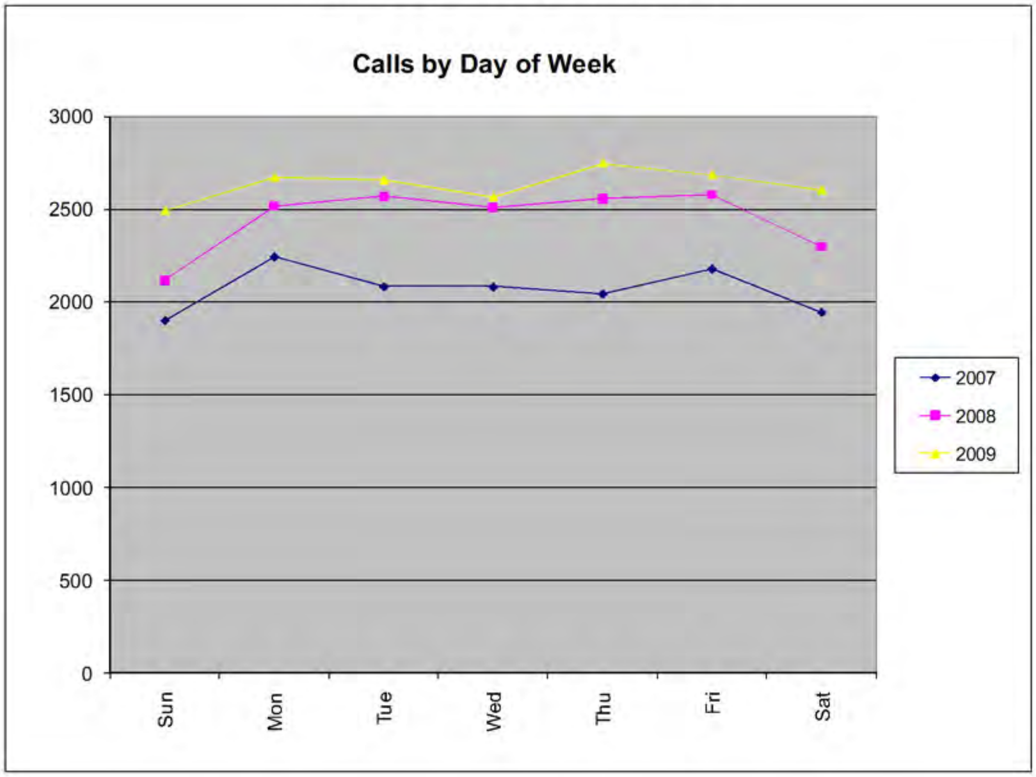
Year	Population	Calls	Calls/1000	Calls/Capita
1991	141,015	6,720	47.7	0.0477
1992	144,466	7,371	51.0	0.0510
1993	146,525	7,512	51.3	0.0513
1994	149,791	7,703	51.4	0.0514
1995	153,164	8,252	53.9	0.0539
1996	156,148	8,312	53.2	0.0532
1997	162,106	8,646	53.3	0.0533
1998	167,103	9,440	56.5	0.0565
1999	174,319	9,084	52.1	0.0521
2000	181,613	9,697	53.4	0.0534
2001	191,220	10,429	54.5	0.0545
2002	200,798	11,161	55.6	0.0556
2003	208,997	11,894	56.9	0.0569
2004	217,512	12,422	57.1	0.0571
2005	224,006	11,739	52.4	0.0524
2006	227,850	13,990	61.4	0.0614
2007	231,157	14,368	62.2	0.0622
2008	234,011	14,865	63.5	0.0635
2009	237,595	15,665	65.9	0.0659

This increase may have a number of underlying factors but two are most likely. First is the "aging of the population". Projections from SANDAG (San Diego Association of Governments) and the U.S. Census Bureau show an overall increase in population over age 55 for most of the United States as the "Baby Boomers" enter retirement years. This is important because this age group tends to use emergency services at a higher rate than younger age groups.

The second factor is the cost of health care. More and more people are using the emergency medical services as a primary care provider. This includes many types of calls that might be more efficiently handled at a doctor's office or non-emergency medical provider such as an urgent care facility.

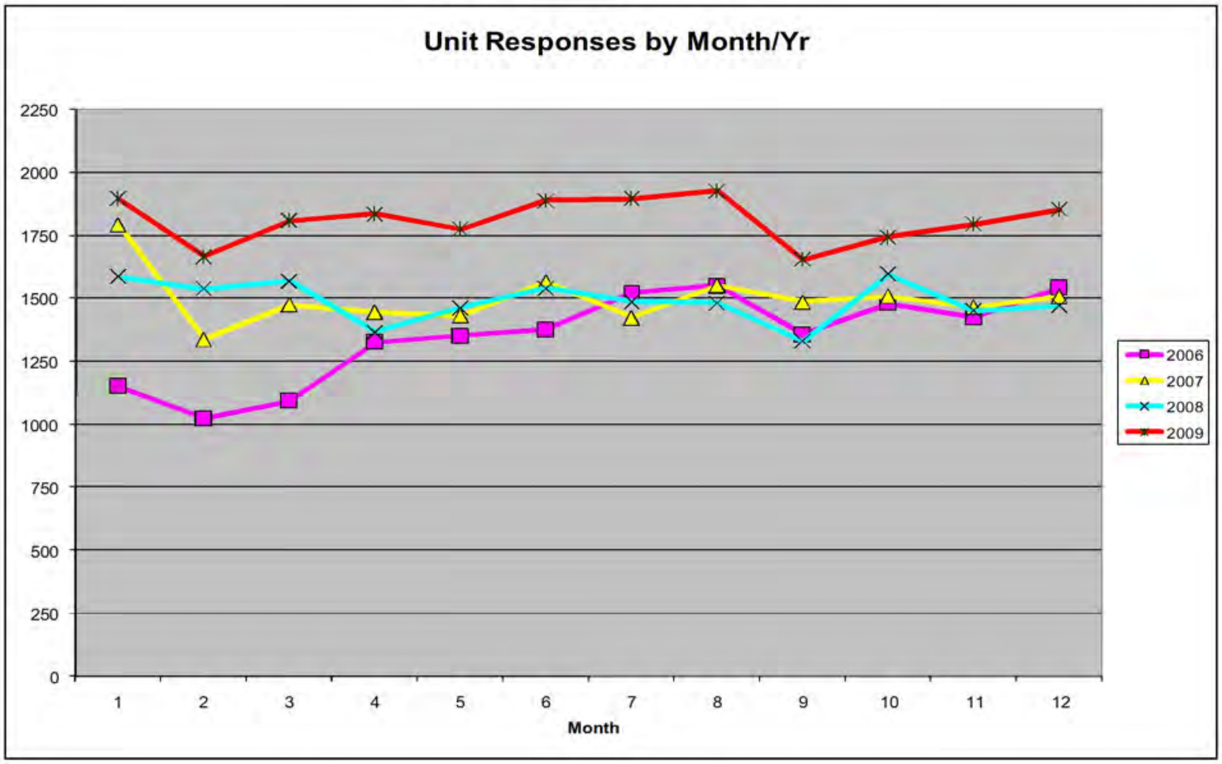
When looking at the system level of performance, it is important to see if the day of week or time of day has an impact on call loading. Figure 26 shows the types of calls by the day of week. The variation is quite limited.

Figure 26: Calls by Day of Week



This trend continues to be the same from the previous work done. When calls are examined by month of year (Figure 27), there is a little more variation but it is not significant.

Figure 27: Call by Month of Year



Time of day does have an impact on the number of calls. Calls tend to increase in the hours that people are normally active. This is shown in Figure 28, where calls tend to pick up around 7:00 or 8:00 AM and stay busy until around midnight.

Figure 28: Calls by Hour of Day

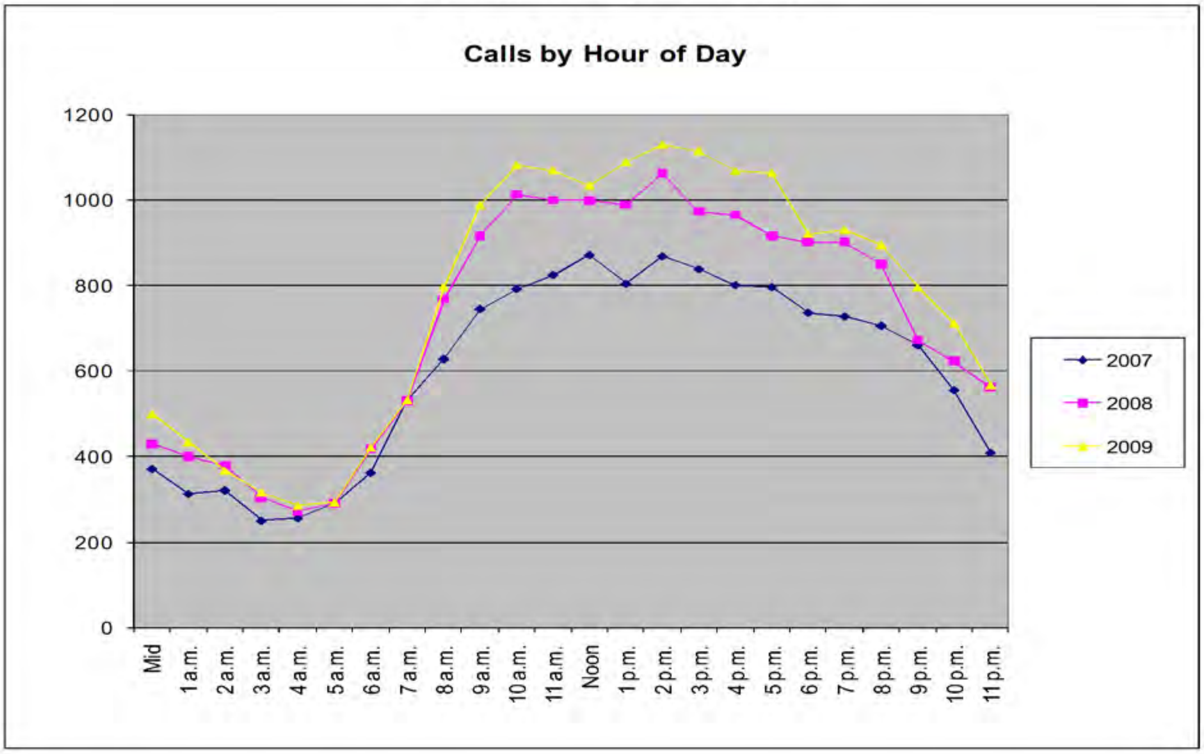
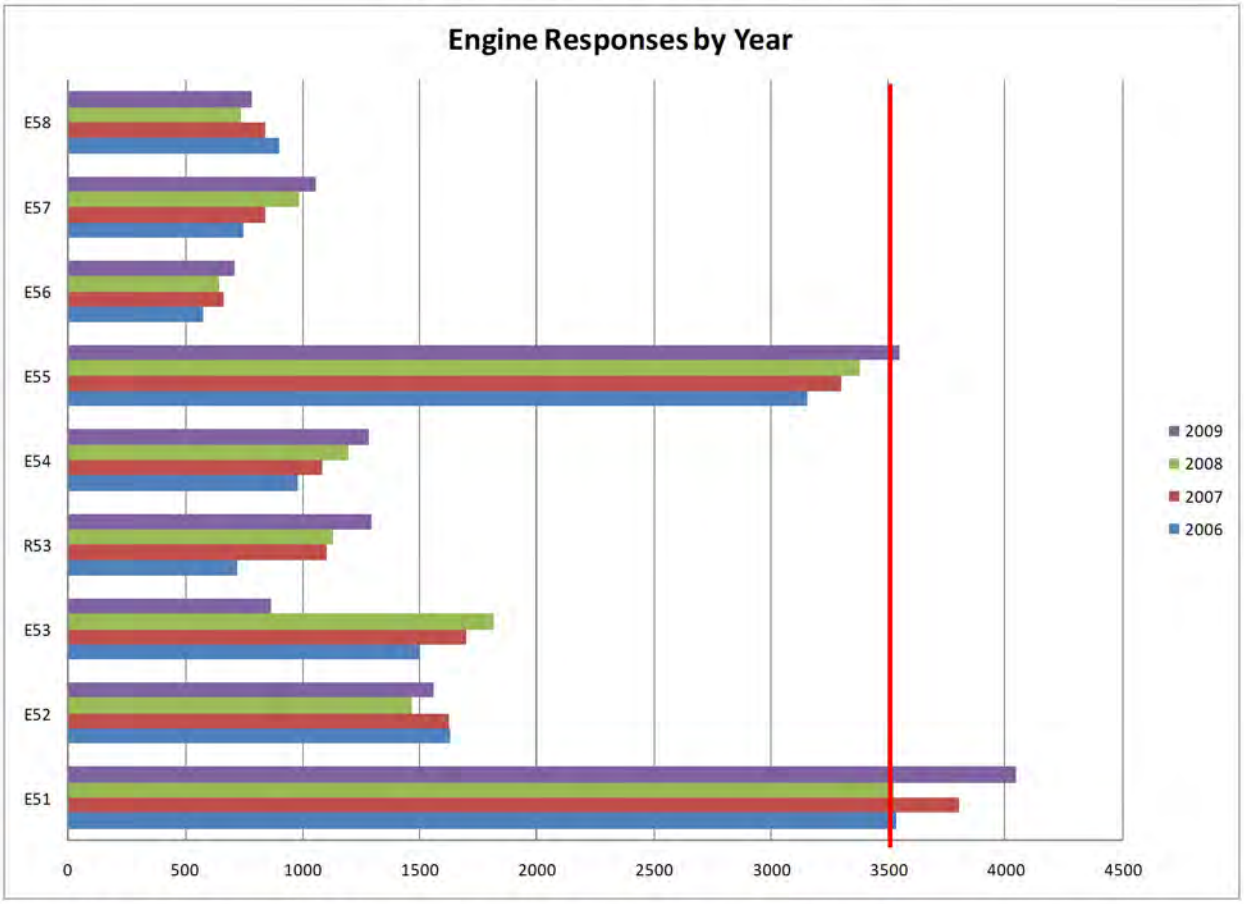


Figure 29, Figure 30, and Figure 31 illustrate the relationship between calls for service and the units/stations that serve the community. Only two units, E51 and E55, have a sufficient number of calls to warrant concern over workload issues at the current call loading. Future growth and increased workload could have an impact on these two units in the immediate future. FS01 had two units assigned and thus has capacity for additional calls, whereas FS05 does not. Figure 31 shows the call loading for T51 that is currently assisting E51.

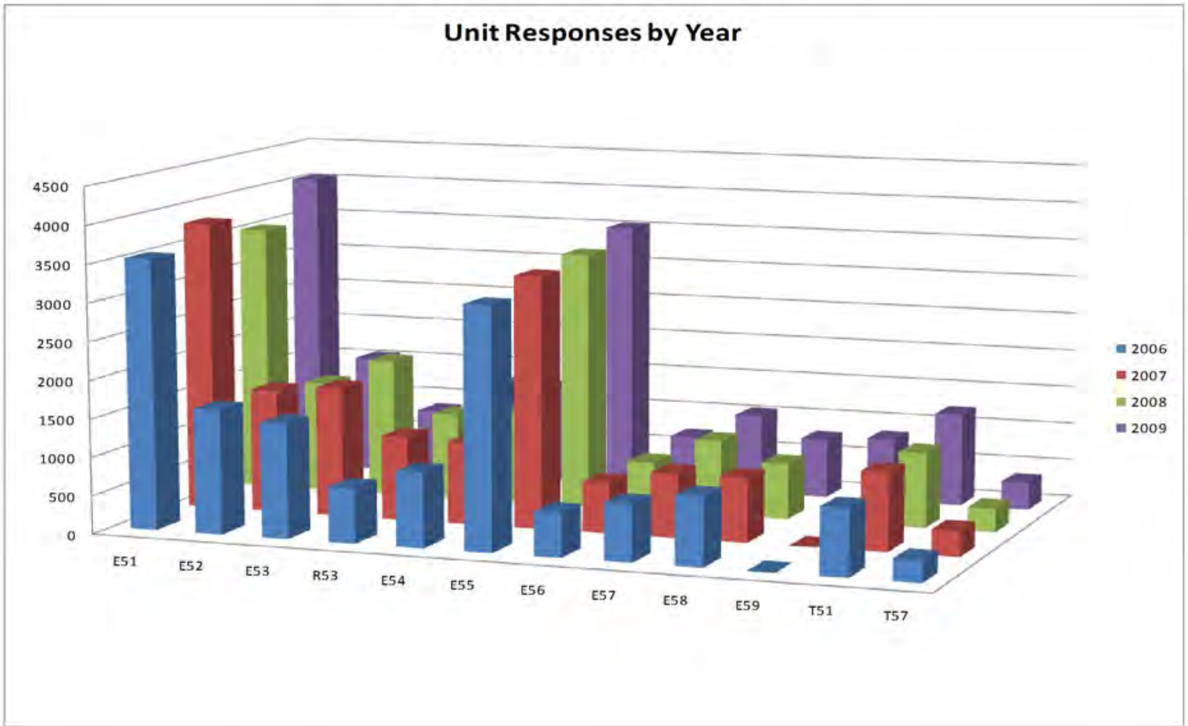
Figure 29: Engine Responses by Year



Note: At 3,500 calls per year (red line above), a unit is considered to be at maximum for performance at the 80th percentile. In the figure E53 is a composite of E53 and E59 from FS09

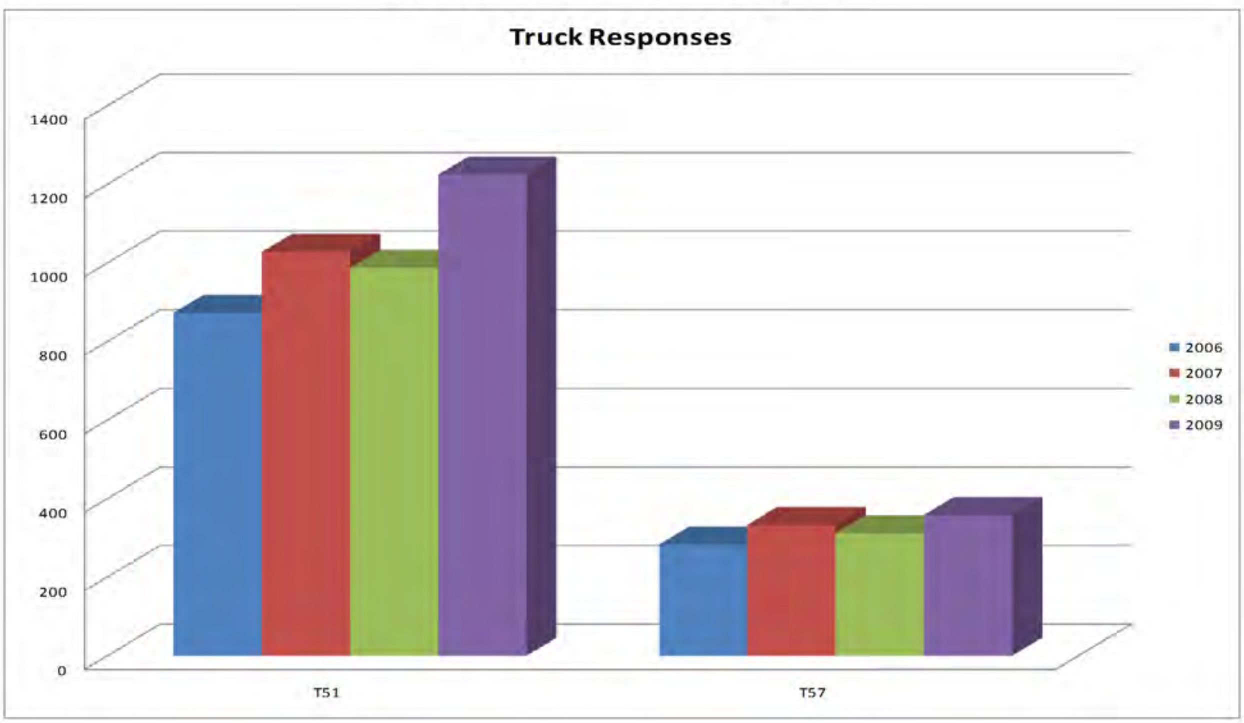
Viewing all of the units at the same time in Figure 30 we see the distribution of the workload. It should be noted that E53 and R53 shared the majority of FS03's service area and some of FS05 and FS02. Workload shifts will occur now that R53 no longer has a dedicated first due area to service.

Figure 30: Unit Responses by Year



Workload on both trucks is increasing.

Figure 31: Truck Responses by Year



Population

The CVFD provides direct emergency services to an estimated population of 273,595. The latest population data available for analysis can be used to provide insight into the specific nature of the population and housing served by the department. Several interesting points of demographic data are provided in the following tables, which were derived from the growth documents published by SANDAG.

Figure 32: SANDAG Population Trend

FAST FACTS
Chula Vista
SANDAG
San Diego's Regional Planning Agency

Jurisdiction Facts

Acres	Square miles	Incorporated
32,572	50.9	1911

Population Trends (1980 - 2010)

	1980	1990	2000	2010
Total Population	83,927	135,163	173,556	237,595
Growth from Prior Period		61%	28%	37%

The SANDAG Preliminary 2030 Growth Forecast indicates that the South San Diego County region will continue to have significant growth over the next 20 years. The current estimate by SANDAG projects the City to have a population increase of 68,000 by the year 2030.

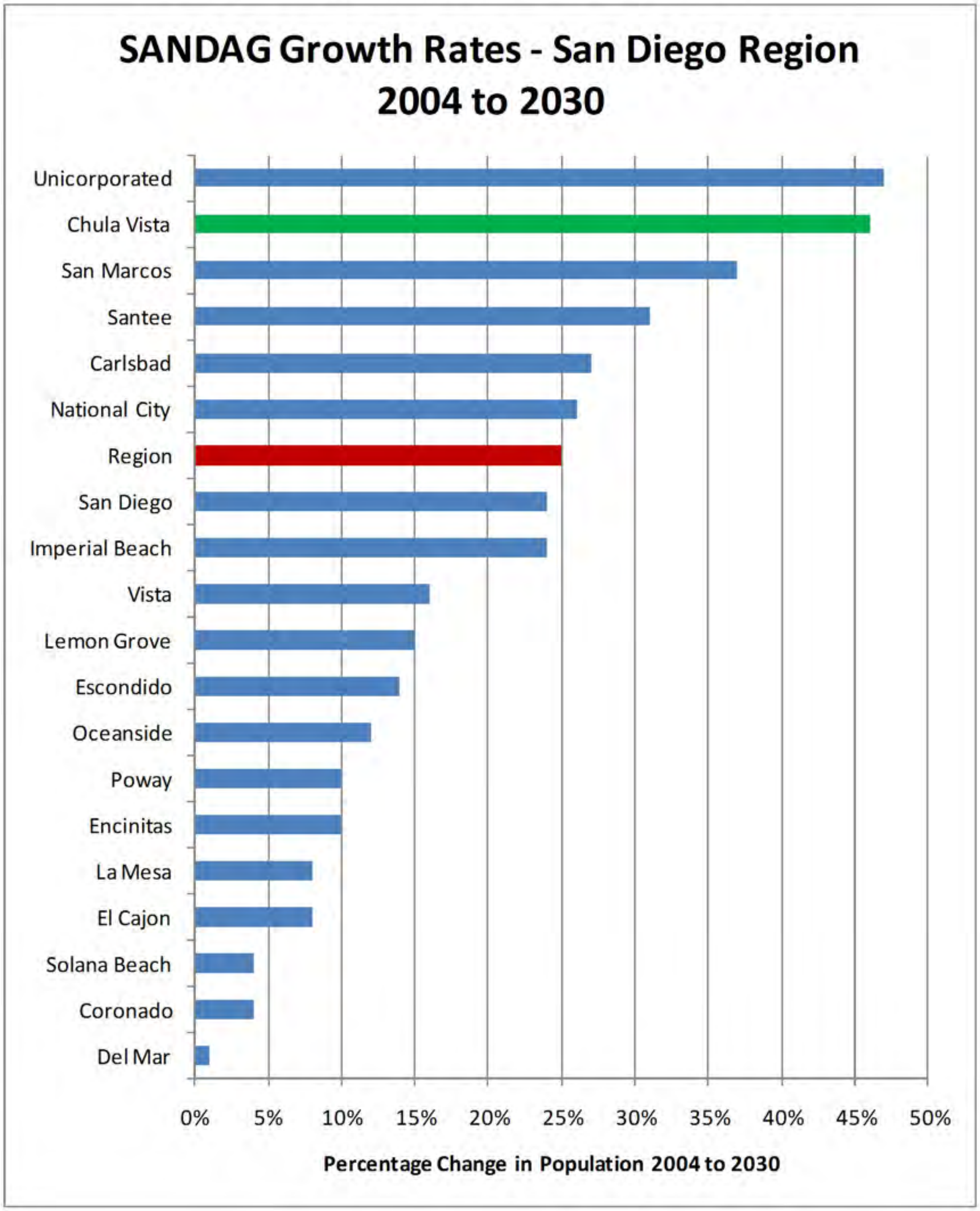
Figure 33: Population Projections (SANDAG)

Total Population by Jurisdiction
San Diego Region, 2004 to 2030

	2004	2010	2020	2030	2004 to 2030 Change	
					Number	Percent
Carlsbad	92,695	109,611	119,095	127,046	34,351	37%
Chula Vista	208,675	248,174	289,304	316,445	107,770	52%

Chula Vista is expected to grow significantly with only the unincorporated county areas growing at a faster rate, as shown in Figure 34.

Figure 34: SANDAG Growth Rates by Jurisdiction



In addition to the total volume of growth, the population in general will be getting older with the number of people aged 65 to 84 more than doubling (see Figure 35). In fact, the median age in the San Diego Region will increase to nearly 40 years old. Regional growth will increase about 32 percent while the older community will increase about four times that rate (125 percent) with about half of the overall increase being older citizens. The region will see an increase of over 400,000 older citizens and Chula Vista is likely to see a proportionate share.

Figure 35: Population Change by Age

Population Change by Age Group
San Diego Region, 2004 to 2030

	2004	2030	2004 to 2030 Change	
			Number	Percent
0 to 17	762,487	834,109	71,622	9%
18 to 64	1,921,261	2,409,282	488,021	25%
65 to 84	284,010	640,102	356,092	125%
85 and older	45,256	101,260	56,004	124%
REGION	3,013,014	3,984,753	971,739	32%
Median Age (Years)	33.7	39.0	5.3	16%

Source: 2030 Regional Growth Forecast Update

The current SANDAG estimates do not include changes envisioned by the Chula Vista General Plan Updates under consideration. With the addition of the proposed changes to the Chula Vista Planning Areas, including locations outside of the current city boundaries, Chula Vista is expected to have a population of between 323,900 and 344,100 by the year 2030.

The General Plan Land Use Element divides the city into four large planning areas consisting of Bayfront, East, Northwest, and Southwest, as shown in Figure 36, Figure 37, and Figure 38.

Figure 36: Chula Vista Population Projections

Chula Vista Projection Population			
Planning Area	**Year 2004***	**Year 2030** 2005 GPU**	**Year 2030**** Proposed**
Bayfront	0	2,500	3,800
Southwest	53,560	61,900	61,900
Northwest	56,930	74,800	74,800
East (incorporated area)	98,710	157,700	176,600
East (unincorporated area	13,100	27,000	27,000
Total:	**222,300**	**323,900**	**344,100**

Notes:

* Source: Year 2004 population estimate derived from State DOF Jan. 1, 2004 estimate for the City of Chula Vista and 2000 Census for unincorporated area.

** Year 2030 population estimate derived using year 2000 Census and State DOF factors.

*** "East (unincorporated area)" includes the Sweetwater and East Otay Ranch Planning Subareas, with most of the growth occuring in the East Otay Ranch Planning Subarea

**** Year 2030 proposed population assumption per OLC proposed project and Land Offer Agreement are subject to further review and refinement

Figure 37: City Planning Areas

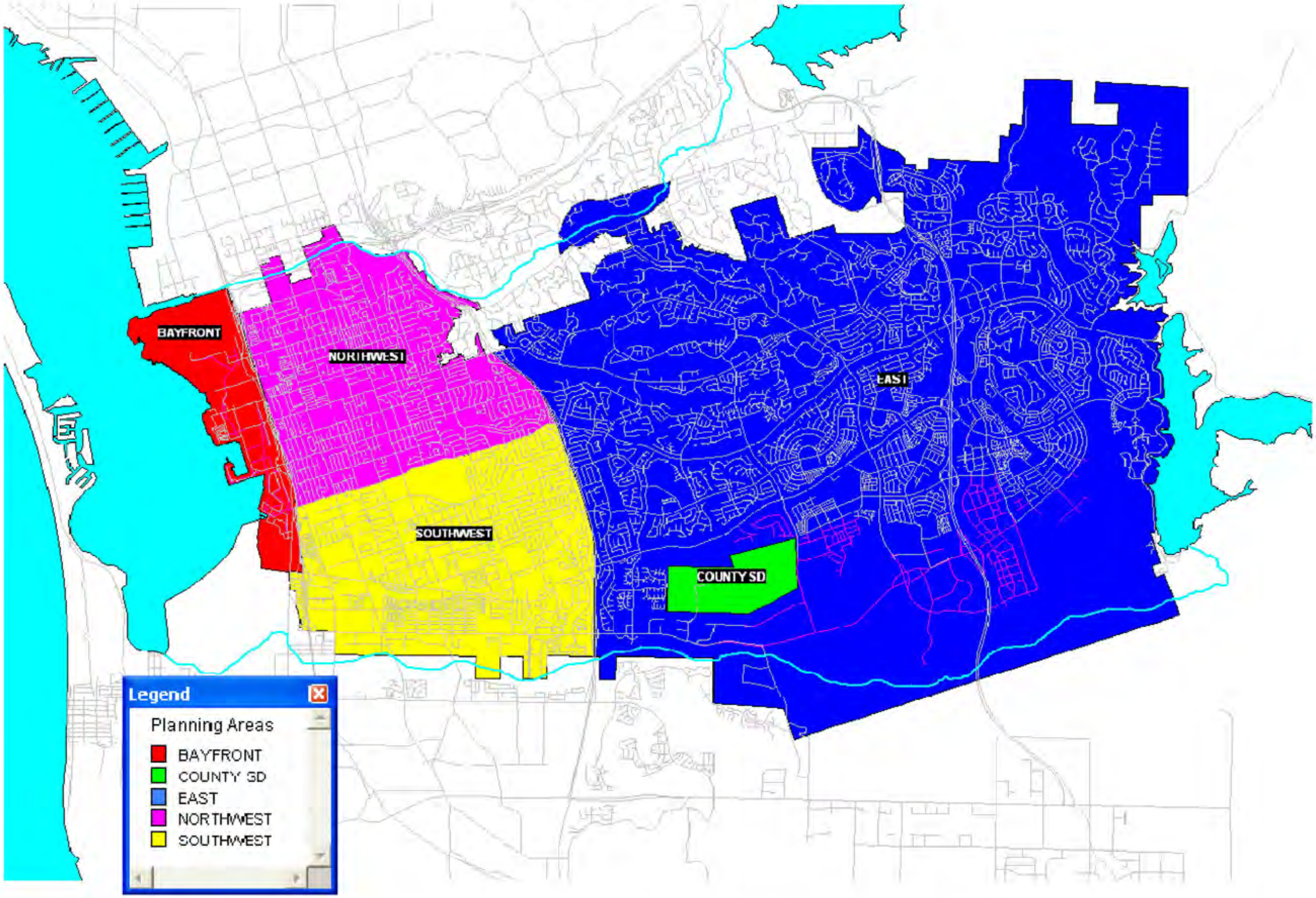
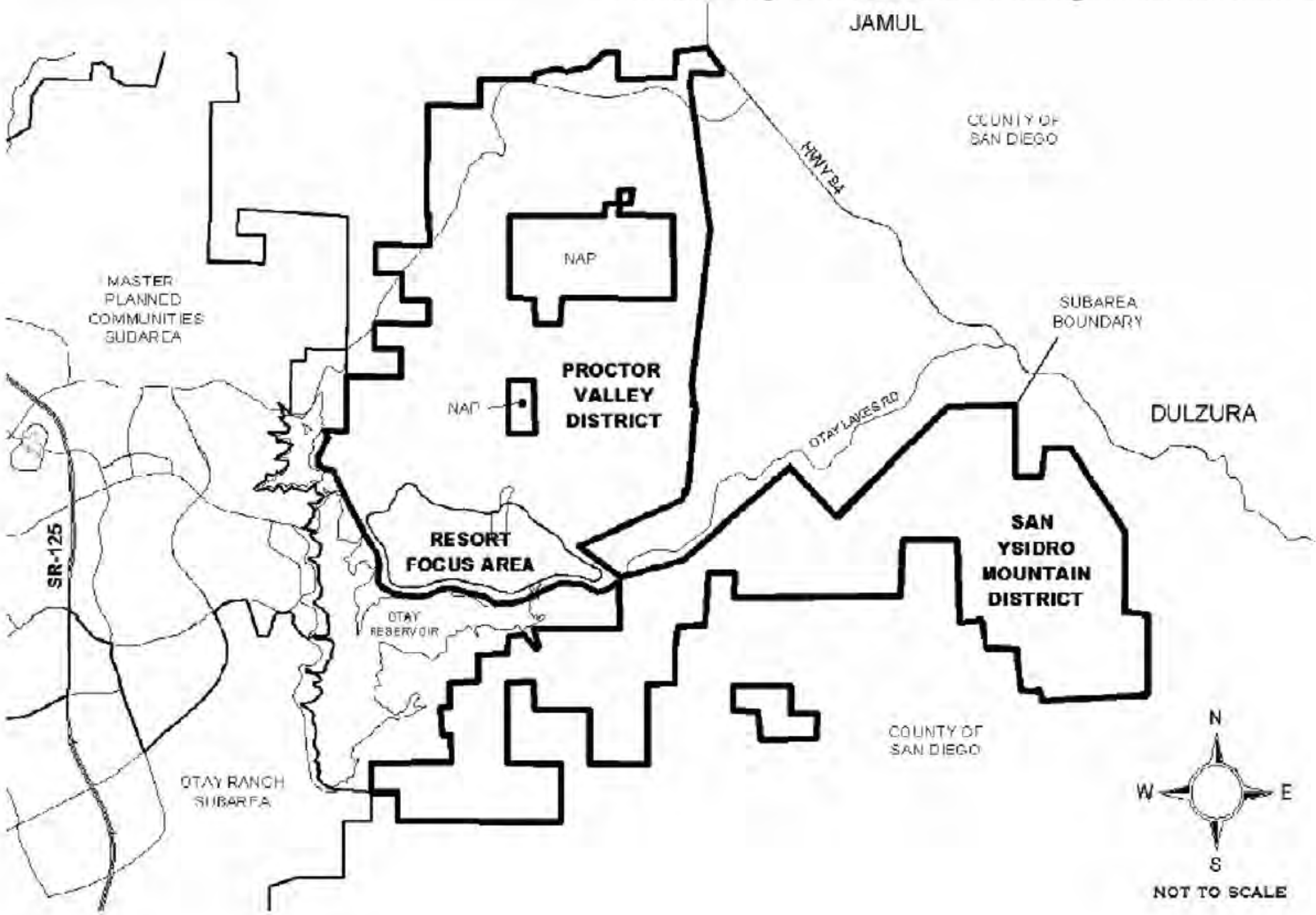


Figure 38: East Unincorporated Subareas

East Planning Area

Unincorporated East Otay Ranch Subareas



Growth Projections

Growth projections within the city are based on development that is currently in process and changes in the zoning and general plan as anticipated in the current update. These projections have been made using the following assumptions:

- No new building caps or restrictions are placed on development.
- Public policy towards development remains unchanged.
- The Growth Management Thresholds are not exceeded.
- The housing market remains steady.
- The General Plan Update as currently approved is implemented.
- A four-year college/university will be developed at the university site in the east.
- The regulatory development processing schedule remains as it is currently.

With these assumptions in place, projections of population within the four large planning areas have been made. The largest growth continues to be in the east, mostly in the Otay Ranch sub areas. The 2005 Annual Growth Management Review Cycle estimated that all growth from new residential development within the existing east area would be completed by the year 2009 with the exception of the Otay Ranch area, which could be completed by the year 2015. This has essentially happened. The following figures (Figure 39 and Figure 40) show the expected impacts of development on the City's population through the year 2030 as projected in the General Plan Update documents.

Figure 39: Population Projections

Projects	Single Family	Multi-Family	Total Residential[1]	Population Increase*
	Unit	Unit	Unit	Total
Miscellaneous				
Eastlake Greens	33	121	154	408
Eastlake Woods/Vistas	31	494	525	1,336
San Miguel Ranch	174	107	281	825
Rolling Hills Ranch	163	-	163	522
Rancho Del Rey II	10	-	10	32
El Dorado Ridge	-	104	104	260
Bella Lago	83	-	83	266
Bayfront				
Otay	-	-		-
Harbor	-	1,500	1,500	3,754
Visitor Transit population	-	-		N/A
Sweetwater	-	-		-
Southwest**				
South Broadway	-	110	110	274
South Third	-	859	859	2,149
Palomar Gateway	-	1,472	1,472	3,683
Main Street	-	71	71	176
Urban Core**				
I-5 Corridor	-	1,567	1,567	3,921
Mid Broadway	-	336	336	841
E Street Visitor	-	1,151	1,151	2,879
H St. Corridor	-	1,384	1,384	3,463
Downtown Third	-	958	958	2,397
Northwest-other				
Hilltop	-	25	25	63
Lower Sweetwater	-	25	25	63
Total:	**494**	**10,284**	**10,778**	**27,312**

Figure 40: Population Projections - Otay Ranch

Planning Area	Existing Residential (July 2010)	Remaining Capacity Residential		Total[2] Residential	Build-out[1] Maximums	Population[1] Increase
Otay Ranch	Built Unit	Single Family	Multi-Family	Unit	Population	Population
Village 1	3,699	-	-	3,699	10,985	Existing
Village 2	-	986	1,800	2,786	7,661	7,661
Village 3**	-	484	360	844	2,450	2,450
Village 4**	-	130	620	750	1,968	1,968
Village 5	2,852	-	-	2,852	8,285	Existing
Village 6*	2,065	-	118	2,183	6,109	295
Village 7*	521	596	339	1,456	4,348	2,756
Village 8 East**	-	-	3,106	3,106	7,773	7,773
Village 8 West**	-	331	1,719	2,050	5,362	5,362
Village 9**	-	108	3,892	4,000	10,086	10,086
Village 10**	-	-	2,650	2,650	6,632	6,632
University***	-	-	-	-	-	-
Village 11*	1,738	95	471	2,304	6,535	1,483
Planning Area 12	-	-	2,993	2,993	7,490	7,490
Otay Ranch Total: *(City boundaries only)*	**10,875**	**2,730**	**18,068**	**31,673**	**85,684**	**53,956**

Workload Projections

Using the information provided by the GMOC (the City's General Plan) fire department response data and regional projections, it is possible to project future calls for service based on the past experience within the city. By examining call trends over the past 19 years, it is easy to see that not only is call volume rising, but the rate of calls per resident is increasing as well.

Figure 41: Population per Capita

Year	Population	Calls	Calls/1000	Calls/Capita
1991	141,015	6,720	47.7	0.0477
1992	144,466	7,371	51.0	0.0510
1993	146,525	7,512	51.3	0.0513
1994	149,791	7,703	51.4	0.0514
1995	153,164	8,252	53.9	0.0539
1996	156,148	8,312	53.2	0.0532
1997	162,106	8,646	53.3	0.0533
1998	167,103	9,440	56.5	0.0565
1999	174,319	9,084	52.1	0.0521
2000	181,613	9,697	53.4	0.0534
2001	191,220	10,429	54.5	0.0545
2002	200,798	11,161	55.6	0.0556
2003	208,997	11,894	56.9	0.0569
2004	217,512	12,422	57.1	0.0571
2005	224,006	11,739	52.4	0.0524
2006	227,850	13,990	61.4	0.0614
2007	231,157	14,368	62.2	0.0622
2008	234,011	14,865	63.5	0.0635
2009	237,595	15,665	65.9	0.0659

Two issues are present in terms of forecasting new workloads. First is whether or not the data presented has validity with regard to the future. In looking at calls for service in relationship to the increases in population over the past 14 years, the two databases have a correlation of 0.9900. A correlation of 1.0000 is a perfect correlation. This means that changes in one database have a direct relationship with changes in the other database. In this case, an increase in population will result in an increase in calls for service.

The second issue is which factor to use in the projection formula. The rate for 2008 was selected. It is more conservative than the 2009 rate but still encompasses the trend over the period analyzed that is increasing steadily. By taking the 2008 value, it would be more consistent with the trend than to take a five or ten-year average. Conversely, projecting a continued increase in the rate of usage could overstate the workload. Projections were made using the 0.0635 calls per capita rate.

The calls per capita rate was applied to population projections of the future projects within the city as stated in the General Plan projections and is shown in Figure 42 and Figure 43.

Figure 42: Otay Ranch Workload Projections

Planning Area	Population Increase	New Calls
Otay Ranch		
Village 1	Existing	-
Village 2	7,661	486
Village 3	2,450	156
Village 4	1,968	125
Village 5	Existing	-
Village 6	295	19
Village 7	2,756	175
Village 8 East	7,773	494
Village 8 West	5,362	340
Village 9	10,086	640
Village 10	6,632	421
University	-	-
Village 11	1,483	94
Planning Area 12	7,490	476
Otay Ranch Total: (City boundaries only)	53,956	3,426

Residential units are not attributed to the University Planning area. This analysis will be done separately and in conjunction with other development. This facility, with its students, faculty, and activities, is estimated to generate approximately two calls for service per day on average (730 calls per year). This does not assume a very large events center that becomes a regional activities center.

The balance of the city will provide the remainder of the development, or redevelopment, which will produce the population increases through the year 2030. These projects are spread throughout the city. All other workload is based on residential units or hotel rooms.

Figure 43: Workload Projections (Other than Otay Ranch)

Projects	Population Increase	New Calls
Miscellaneous		
Eastlake Greens	408	26
Eastlake Woods/Vistas	1,336	85
San Miguel Ranch	825	52
Rolling Hills Ranch	522	33
Rancho Del Rey II	32	2
El Dorado Ridge	260	17
Bella Lago	266	17
Bayfront		
Otay	-	-
Harbor	3,754	238
Visitor Transit population	N/A	-
Sweetwater	-	-
Southwest**		
South Broadway	274	17
South Third	2,149	136
Palomar Gateway	3,683	234
Main Street	176	11
Urban Core**		
I-5 Corridor	3,921	249
Mid Broadway	841	53
E Street Visitor	2,879	183
H St. Corridor	3,463	220
Downtown Third	2,397	152
Northwest-other		
Hilltop	63	4
Lower Sweetwater	63	4
Total:	27,312	1,734

Together, the projects listed above will add an additional population of 81,268 residents. If the rate of usage stays constant, they will generate another 5,161 calls for service. Using this methodology, the CVFD would be responding to over 20,800 calls for service annually by the year 2030.

Plans are under review for additional development in Villages 3, 8, and 10. This additional development (JPB Proposal) will increase the population of the city by another 20,463 and increase workload by an additional 1,299 calls for service (as shown in Figure 44).

Figure 44: JPB Proposal Projected Workloads

Planning Area	Existing Residential (July 2010)	Remaining Capacity Residential		Total * Residential	Build-out[1] Maximums	Population[1] Increase	New Calls
Otay Ranch	Built Unit	Single Family	Multi-Family	Unit	Population	Population	
Village 3*	-	786	1,336	2,122	5,859	5,859	372
Village 8 East*	-	1,178	2,005	3,183	8,788	8,788	558
Village 10*	-	1,000	1,045	2,045	5,816	5,816	369
Otay Ranch Total: *(City boundaries only)*	-	**2,964**	**4,386**	**7,350**	**20,463**	**20,463**	**1,299**

Notes:

* Preliminary Proposed GPA/GDPA residential units assumption as of July 2010 are subject to further review and refinement

[1] Population coefficient of 3.3 per household for Single Family and 2.58 for Multi-Family residential, also applying average vacancy of 3.01% as reported in 2010 Department of Finance.

Calls for Service Type and Locations

The new workloads have been applied using the breakdown of current calls in relationship to the existing 2009 workload. The detailed breakdown is shown below.

Figure 45: Workload Breakdown by Percentage of Whole

Als	Rescue	Strufire	Other	Total
85.3%	0.6%	1.2%	12.9%	100.0%

Projected workload was divided into Fire, EMS, Rescue, and Other from the categories listed above and distributed to individual response grids. Using call generation from the various projects, additional workload was applied to various response zones around the city to determine the impact of the added workload on the existing and proposed delivery system under the current General Plan (Figure 46). A 9 percent drop in travel time performance was measured for the entire system (first unit arrival) when the year 2030 workload was applied without new resources (Figure 47). Other performance measurements varied in their impact; EFF travel time fell 9 percent and IAF fell 1 percent.

Figure 46: Projected 2030 Workload Locations

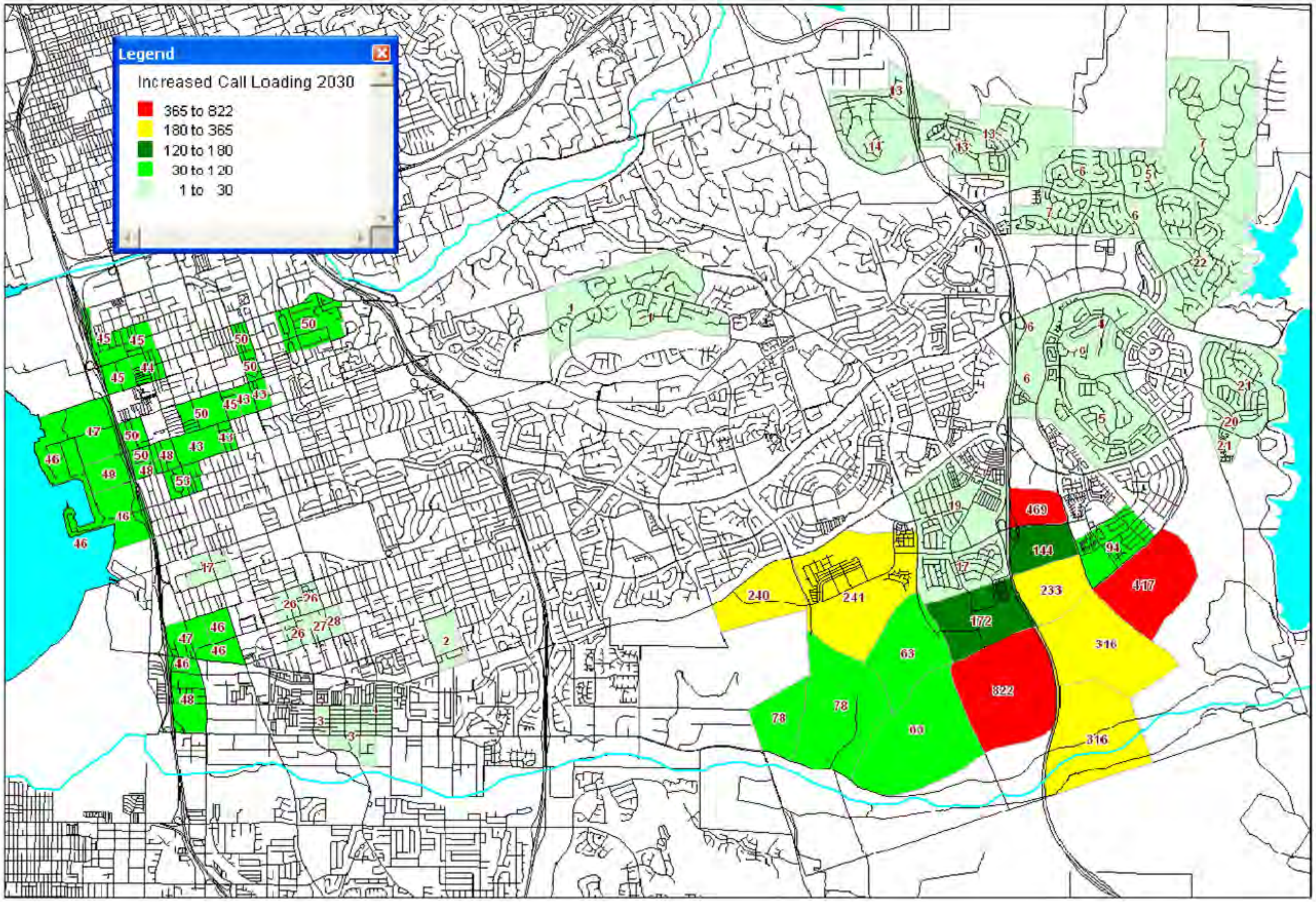


Figure 47: Workload Impact on Performance

Current Workload/Streets

Scenario Definition & Performance

Scenario: Updated Base June 2010 Current Street Speed limts

PDGs Analysed:
All

Performance across all analysed areas:
Analysis based On "June 2010 Current Street Network - Speed limts" Road Network.
"Current 2009 workloads" Workloads Used

INCIDENTS PERFORMANCE:

Incident Type Groups "ALS Incidents" :

Incidents Analysed: 13180
(A) First Unit Call Receipt to OnScene(FURpOsA) <= 6:00 : 63%. Avg. 5:37.
(B) First Unit Travel(FUEnOsA) <= 4:00 : 72%. Avg. 3:16.
(C) First Unit Assign to OnScene(FUAsOsA) <= 7:00 : 95%. Avg. 4:38.
(D) First Paramedic Dispatch to OnScene(FParaDpOsA) <= 10:30 : 97%. Avg. 7:04.
(E) First AMR ALS Unit Dispatch to OnScene(FALSDpOsA) <= 10:00 : 95%. Avg. 7:04.
(F) First AMR BLS Unit Dispatch to OnScene(FBLSDpOsA) <= 12:00 : 0%. Avg. 24:35.
(G) Second Engine Call Receipt to OnScene(SERpOsA) <= 10:00 : 88%. Avg. 8:31.

Incident Type Groups "Rescue Incidents" :

Incidents Analysed: 91
(H) First Unit Call Receipt to OnScene(FURpOsR) <= 7:00 : 61%. Avg. 6:30.
(I) First Unit Travel(FUEnOsR) <= 4:00 : 69%. Avg. 3:08.
(J) First Paramedic Dispatch to OnScene(FParaDpOsR) <= 10:30 : 90%. Avg. 7:48.
(K) First Truck Call Receipt to OnScene(FTRpOsR) <= 6:00 : 5%. Avg. 10:43.
(L) EFF Call Receipt to OnScene(EFFRRpOsR) <= 10:30 : 47%. Avg. 10:43.

Incident Type Groups "StruFire Incidents" :

Incidents Analysed: 185
(M) First Unit Call Receipt to OnScene(FURpOsS) <= 6:00 : 46%. Avg. 6:11.
(N) First Unit Travel(FUEnOsS) <= 4:00 : 80%. Avg. 2:55.
(O) First Unit Assign to OnScene(FUAsOsS) <= 7:00 : 96%. Avg. 4:26.
(P) Second Unit Call Receipt to OnScene(SURpOsS) <= 10:00 : 95%. Avg. 7:21.
(Q) First Engine Call Receipt to OnScene(FERpOsS) <= 5:00 : 14%. Avg. 6:28.
(R) Second Engine Dispatch to OnScene(SEDpOsS) <= 10:00 : 97%. Avg. 6:52.
(S) Initial Attack Force (E,4FF) Assign to OnScene(IAFAsOsS) <= 7:00 : 83%. Avg. 5:36.
(T) EFF High (E, 22FF) Call Receipt to OnScene(EFF22RpOsS) <= 13:30 : 87%. Avg. 11:27.
(U) EFF Normal (E, 14FF) Enrte to OnScene(EFF14EnOsS) <= 8:00 : 87%. Avg. 6:20.
(V) EFF Normal (E, 14FF) Call Reciept to OnScene(EFF14RpOsS) <= 10:30 : 80%. Avg. 9:25.

Buildout Workload/Streets

Scenario Definition & Performance

Scenario: Updated Buildout June 2010 Speed limts

PDGs Analysed:
All

Performance across all analysed areas:
Analysis based On "June 2010 Proposed Street Network - Speed Limits" Road Network.
"Buildout 2030 workloads" Workloads Used

INCIDENTS PERFORMANCE:

Incident Type Groups "ALS Incidents" :

Incidents Analysed: 17871
(A) First Unit Call Receipt to OnScene(FURpOsA) <= 6:00 : 54%. Avg. 5:56.
(B) First Unit Travel(FUEnOsA) <= 4:00 : 63%. Avg. 3:35.
(C) First Unit Assign to OnScene(FUAsOsA) <= 7:00 : 91%. Avg. 4:55.
(D) First Paramedic Dispatch to OnScene(FParaDpOsA) <= 10:30 : 91%. Avg. 7:35.
(E) First AMR ALS Unit Dispatch to OnScene(FALSDpOsA) <= 10:00 : 87%. Avg. 7:35.
(F) First AMR BLS Unit Dispatch to OnScene(FBLSDpOsA) <= 12:00 : 0%. Avg. 22:59.
(G) Second Engine Call Receipt to OnScene(SERpOsA) <= 10:00 : 76%. Avg. 8:57.

Incident Type Groups "Rescue Incidents" :

Incidents Analysed: 129
(H) First Unit Call Receipt to OnScene(FURpOsR) <= 7:00 : 56%. Avg. 6:44.
(I) First Unit Travel(FUEnOsR) <= 4:00 : 64%. Avg. 3:22.
(J) First Paramedic Dispatch to OnScene(FParaDpOsR) <= 10:30 : 78%. Avg. 8:35.
(K) First Truck Call Receipt to OnScene(FTRpOsR) <= 6:00 : 5%. Avg. 10:29.
(L) EFF Call Receipt to OnScene(EFFRRpOsR) <= 10:30 : 50%. Avg. 10:29.

Incident Type Groups "StruFire Incidents" :

Incidents Analysed: 250
(M) First Unit Call Receipt to OnScene(FURpOsS) <= 6:00 : 39%. Avg. 6:25
(N) First Unit Travel(FUEnOsS) <= 4:00 : 73%. Avg. 3:09.
(O) First Unit Assign to OnScene(FUAsOsS) <= 7:00 : 95%. Avg. 4:40.
(P) Second Unit Call Receipt to OnScene(SURpOsS) <= 10:00 : 95%. Avg. 7:26.
(Q) First Engine Call Receipt to OnScene(FERpOsS) <= 5:00 : 11%. Avg. 6:44.
(R) Second Engine Dispatch to OnScene(SEDpOsS) <= 10:00 : 93%. Avg. 7:17.
(S) Initial Attack Force (E,4FF) Assign to OnScene(IAFAsOsS) <= 7:00 : 82%. Avg. 5:41.
(T) EFF High (E, 22FF) Call Receipt to OnScene(EFF22RpOsS) <= 13:30 : 75%. Avg. 12:00.
(U) EFF Normal (E, 14FF) Enrte to OnScene(EFF14EnOsS) <= 8:00 : 78%. Avg. 6:42.
(V) EFF Normal (E, 14FF) Call Reciept to OnScene(EFF14RpOsS) <= 10:30 : 70%. Avg. 9:47.

New Risks

Chula Vista is about to embark on a journey that will change the nature of the city and its residents. Three aspects of the General Plan Update and specific projects currently envisioned will create a large amount of this change in terms of the fire department's role and responsibility.

First, is the Bayfront area. With the upgraded marina, activity centers, and resort hotels, the Bayfront area will become a destination location for travelers. This area will bring high density, high traffic volume, and activities that tend to require fire department services. For the most part, traveling populations tend to be mobile and in relatively good health. But the nature of vacation and/or recreational uses is that they tend to create an environment where people do things they might not normally do. This increases the rate of accidents and incidents that require fire department services. This change could take the form of fires on pleasure craft, additional needs for water rescue services, increased calls for people away from their primary medical providers, or people simply overindulging in the good times that are to be had at a destination resort.

Second is the nature of building stock or inventory within the city. Currently, the area has only one high-rise building and limited structures of height greater than the fire apparatus ground ladder complement which are not protected with built-in fire protection systems. The nature of the development outlined in the General Plan Update shows a much larger usage of mid-rise and high-rise structures for both business and residential occupancies.

Even with installed fire protection, these structures require large numbers of firefighters to combat even a simple room and contents fire. In fact, it is unlikely that the CVFD will be able to combat a high-rise fire without substantial mutual aid resources; there are few large departments in the United States that can do this. A working fire in a high-rise building will take up to 200 firefighters. This is not to say that Chula Vista should have this many firefighters on duty, but it should be able to get this level of assistance from the region in the event that a high-rise fire occurs. Obviously, the larger the number of these structures, the greater the probability that such an event will occur.

Finally, the nature of building occupancies needs to be considered. The City is moving toward mixed use and live/work occupancies that are part of the new urbanism currently being planned for most large cities in this region. Sustainable development and walkable communities are good concepts, but they take a different kind of protection and service delivery. Access becomes an issue, and the types of street designs and building configurations that help make these communities more livable make them harder to provide services in. Simple issues such as access to the dwelling unit with an ambulance or even a gurney can be complicated by features designed to limit vehicle access and increase pedestrian activities. Great care should be taken by the fire prevention staff in the development of these types of occupancies and building product.

Density of dwelling units is a doubled-edged sword for the fire service. Higher densities tend to make the distribution of resources work better. The larger number of calls in smaller areas normally has a positive impact on distribution performance. The other end of the spectrum is that density causes more calls for service. The more compact the living area, the greater the impact of an emergency on the surrounding areas. For example, a small room and contents fire in a single family dwelling in a typical suburban neighborhood would normally displace five people. This same fire in a mid-rise or high-rise residential building could displace hundreds of people if utilities could not be restored and the building cleared of smoke and water. Thus, concentration issues and resource utilization time (commit time) is increased. At a certain point, density requires buildings to be of a greater height. The increase in the vertical aspect of any emergency will require more personnel, equipment, and time to complete the same task.

Future Development/Redevelopment

The single largest issue regarding future development or redevelopment for the fire service delivery system in Chula Vista is the provision of adequate infrastructure. Since time is one of the most critical factors in the delivery of emergency services, road networks are extremely important to the fire department's ability to provide services in a timely and cost effective manner. Three issues tend to rise to the top over and over—access, timing, and connectivity.

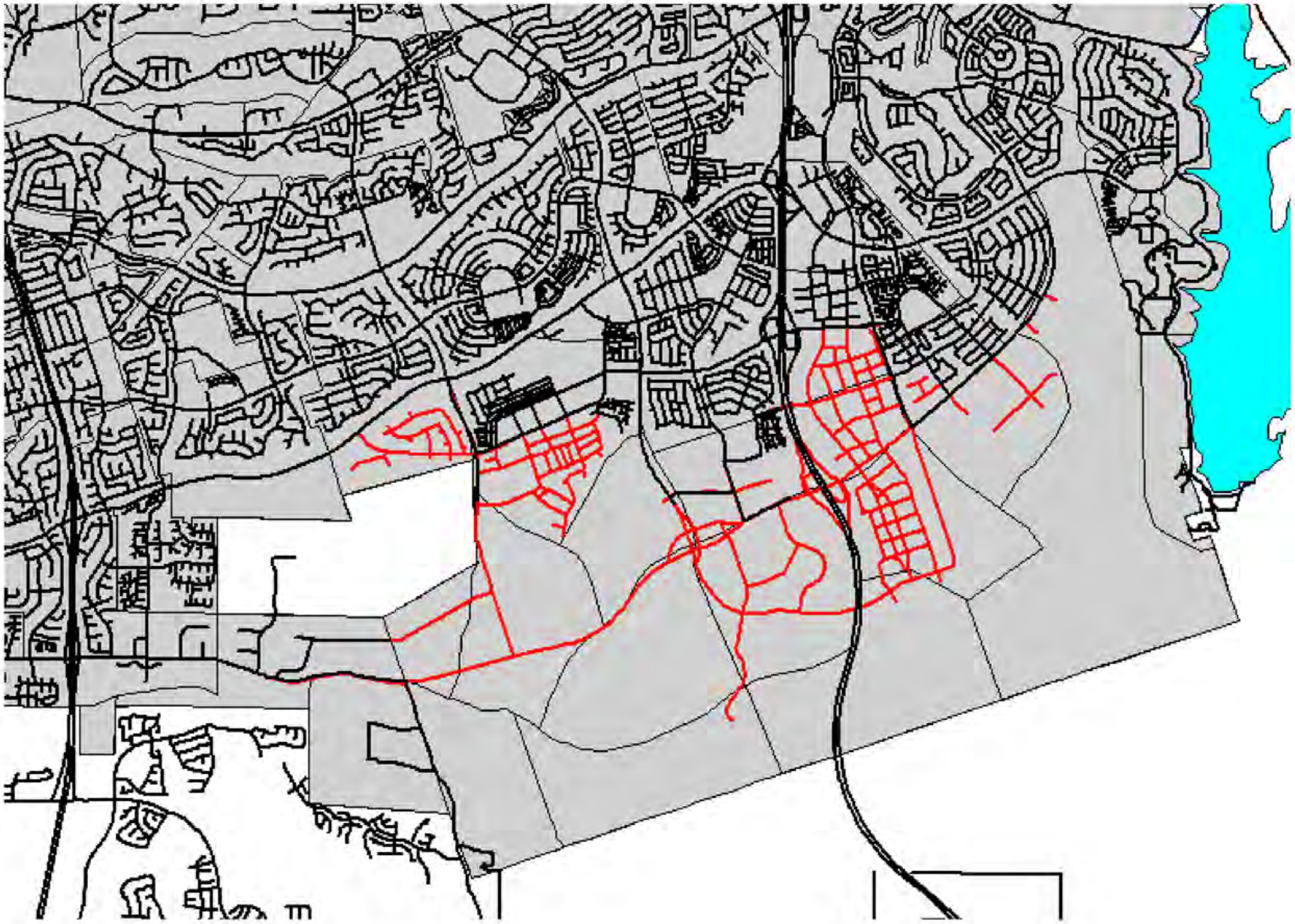
Access is one of the issues that fire prevention staff deal with constantly. Having access to all sides of a building, fire lanes, hose pull calculation, and the ability of the fire department to setup and stage equipment at the scene of an emergency are key issues that are normally addressed in the plan review process. Most of these issues are project specific and can be addressed as such.

The issues of timing and connectivity are more applicable to the large scope of development planning. A great deal of time and effort are required to model traffic flow and trips generated by the project. Since this keeps the traffic moving, the fire department is a beneficiary of this work. The impacts to emergency services come when the traffic system is compromised by the lack of circulation that moves resources from the fire station into the community in the fastest, most direct route. Sometimes this impact is from the timing of infrastructure that will ultimately be present to serve the community. The interim period may require units to travel great distances to projects until the final infrastructure is completed. While this does not have long-term performance issues, it will make performance in the development area more difficult and likely less successful until the street network is completed.

The issue of connectivity is one that will have long-term impacts on the delivery of services. Large communities with limited ingress and egress points tend to create hard to serve areas. While many factors go into the creation of a new community (such as topography, existing circulation, neighborhood character, and overall quality of life issues), it is essential that the large scale circulation plan have emergency services connectivity from one area to another and from the fire stations to all areas within the community. Without an orientation to this, the fire department will require additional resources and fire stations to serve the community, taking up scarce resources that could be used for other community interests.

This study has used circulation plans provided by the City of Chula Vista to model future services. The following maps show the street network that was developed for the purpose of modeling services in the year 2030. Several key connections are vital to the delivery of services. These include SR125, Rocky Mountain Road/Hunte Parkway Extension, Eastlake Parkway Extension, La Media Road Extension, Main Street Extension, Paseo Ranchero/Heritage Road Extension, Mount Miguel Road Extension/San Miguel Ranch Road, and Birch Road Extension. These are shown in red on Figure 48.

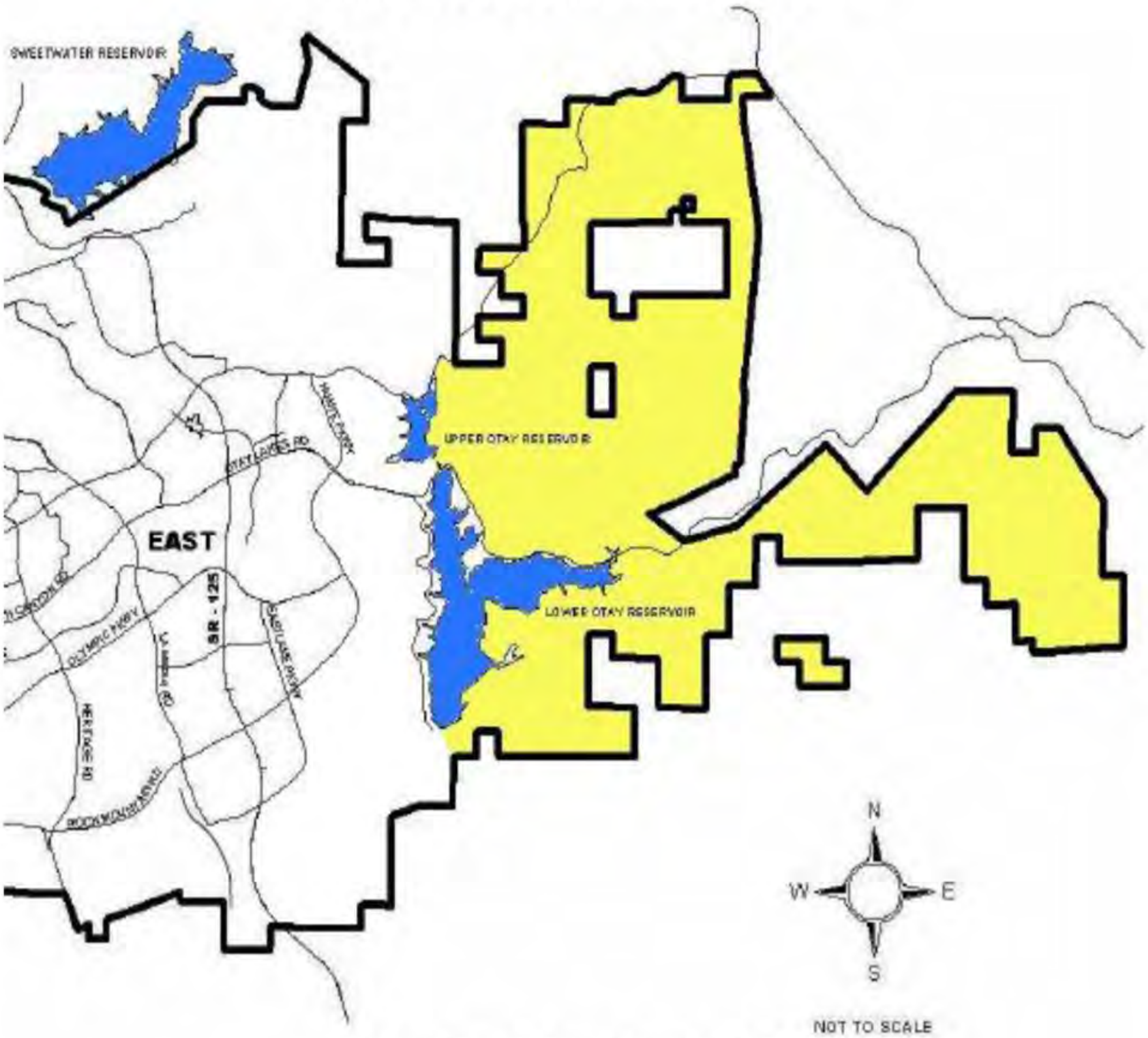
Figure 48: Proposed Streets in Otay Ranch



Regional Growth Issues

This study has not been able to calculate the specific impacts of some regional growth issues. The impact of issues such as expanded traffic on the rail/trolley lines and the location and services to be provided by new hospitals for receiving patients are not known with any degree of certainty at this time and have not been addressed. Decisions within the city's sphere of influence will also have an impact on circulation, fire department resources, and the overall delivery of services. The development areas beyond the existing city boundaries and east of Otay Lakes will require additional detailed study and are addressed here only on a global basis.

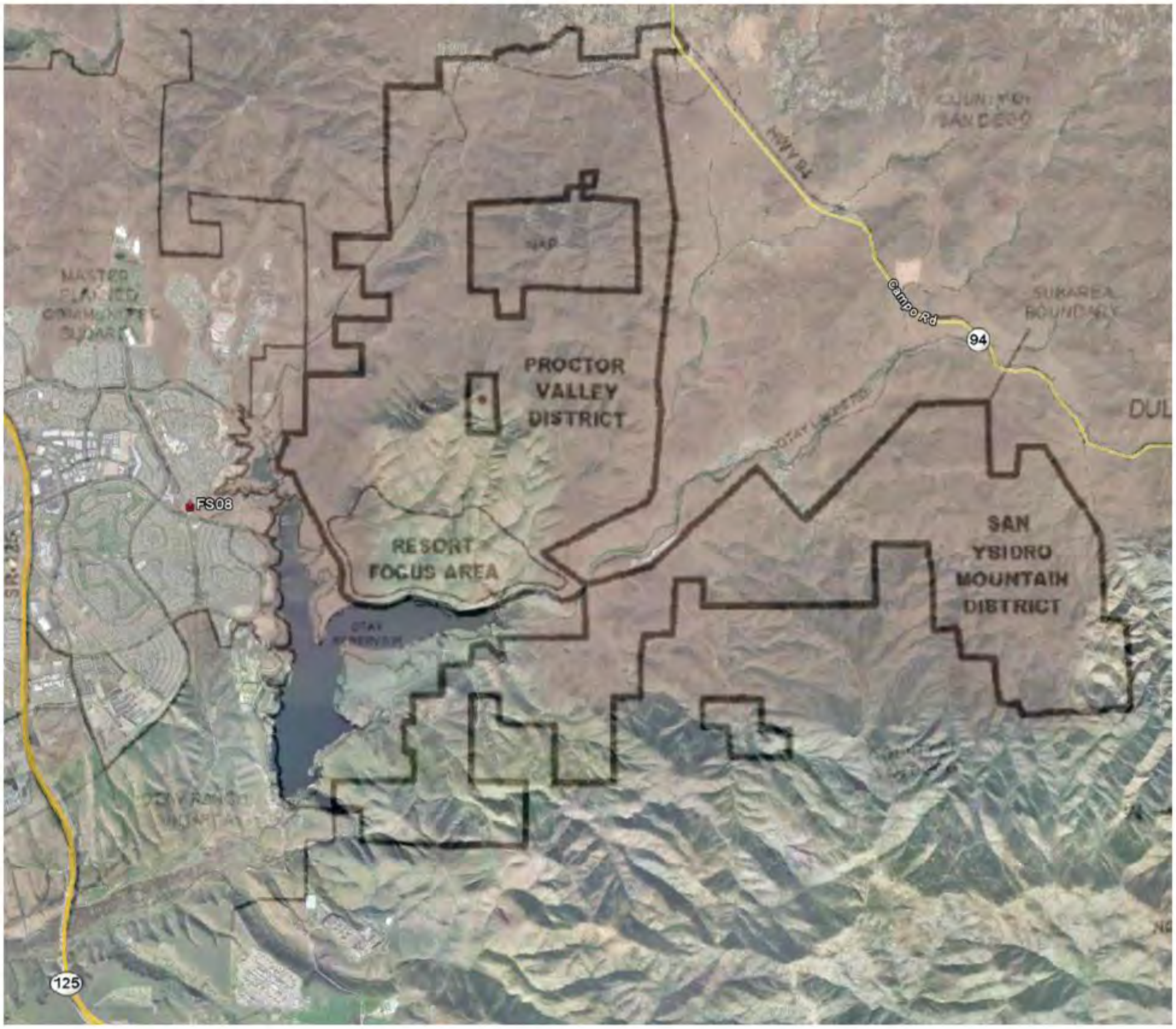
Figure 49: Future Development Areas - East



Future Growth Area Shown in Yellow

The three specific areas east of the city that have potential for development are shown in Figure 50.

Figure 50: Unincorporated East Planning Areas



The Proctor Valley District and San Ysidro Mountain District will be hard to serve, given the topography and lack of conductivity to other developed areas. These areas will likely be developed using a rural standard for deployment. Both areas will have significant wildland interface issues and, if incorporated into the city boundaries, will cause the CVFD to have a large LRA (Local Responsibility Area) protection duty that will require a significant investment in wildland equipment and large exposure for costs associated with fires in this area.

The Resort Focus Area will likely be developed to an urban standard. This area is remote from the balance of the existing service delivery system. The nearest fire station (FS08) is approximately three miles from the center of the Focus Area along the lakefront. Depending on how the area develops, some areas could be 4.5 to 5 miles (travel distance) from FS08. Additionally, the second due engine (2.5 additional miles), third due engine, truck company, and battalion chief (3.5 to 4.5 additional miles) must essentially travel past FS08 to get to the service area. This will significantly increase arrival times. This development area will definitely need a fire station to serve it and may need more than one resource depending on the scale and nature of the development.

Figure 51: Resort Focus Area

Task 3 – Critical Task Analysis

By definition, the scene of an emergency is organized chaos. It is extremely important to study the sequence and nature of the primary or critical tasks that much be performed in order to bring the emergency to a positive conclusion. This is genesis of the Critical Task Analysis. Use of this analysis can be used to determine the number, type, and timing of needed resources to accomplish the tasks at hand. Because the equipment, training, procedures, and knowledge differ from one organization to another, this process should be accomplished by each organization as it moves through the SOC (standard of coverage) process. While most are similar, difference will occur. For Chula Vista, we have used the national studies and conducted a local assessment of the critical tasks and arrival timeframes.

A delayed response, particularly in conjunction with the deployment of limited resources, reduces the ability of the fire department to control the fire in a timeframe that prevents major damage and possible loss of life and increases the danger to firefighters.

> *Successful containment and control of a fire require the coordination of many separate tasks. Fire suppression must be coordinated with rescue operations, forcible entry, and utilities control. Ventilation typically occurs only after an attack line is in place and crews are ready to move in and attack the fire. The incident commander needs up-to-the-minute knowledge of crew activities and the status of task assignments which could result in a decision to change from an offensive to a defensive strategy.*
>
> *Arrival of a firefighting response force must be immediately followed by organization of the resources into a logical, properly phased sequence of tasks, some of which need to be performed simultaneously. Knowing the time it takes to accomplish each task with the allotted number of personnel and equipment is critical. Ideally crews should arrive and intervene in sufficient time to prevent flashover or spread beyond the room of origin.*
>
> *Decision-making about staffing levels and geographic distribution of resources must consider those times when there will be simultaneous events requiring resource deployment. There should be sufficient redundancy or overlap in the system to allow for simultaneous calls and high volume of near simultaneous responses without compromising the safety of the public or firefighters.*[1]

For many years decision makers have asked for studies that would quantify changes in fireground performance based on apparatus staffing levels and on-scene arrival time intervals. The National Institute of Standards and Technology, in cooperation with the IAFF (International

[1] National Institute of Standards and Technology, *Report on Residential Fireground Field Experiments*, April 2010.

Association of Firefighters), the IAFC (International Association of Fire Chiefs), and CFAI (Commission on Fire Accreditation International) conducted experiments that were designed to observe the impact of apparatus staffing levels and apparatus arrival times on the time it takes to execute essential fireground tasks and on the tenability inside the burn prop for a full initial alarm assignment response. The results of this study will likely be used to evaluate the related performance objectives in *NFPA 1710*.

Identifying Critical Tasks

There are some critical tasks that must be conducted by firefighters at structure fires, by rescuers at vehicle accidents and by EMS personnel at a medical aid incident. To create standard levels of response for mitigation actions, an assessment must be conducted locally to determine the capabilities of the arriving companies and individual responders to achieve those critical tasks.

A typical approach to performing a Critical Task Analysis (CTA) is to determine the specific tasks essential to properly mitigate the risk found in the specific community being served. In a smaller, more homogeneous city or district, an analysis of the most common types of fires is all that may be necessary. In most suburban communities this will likely be the single family dwelling, given the number of such structures and the lack of sprinkler protection in most. The baseline for this analysis is the standard residential fire.

> *Regardless of the size of a structure on fire, firefighting crews identify four priorities: life safety of occupants and firefighters, confinement of the fire, property conservation, and reduction of adverse environmental impact. Interdependent and coordinated activities of all fire fighting personnel are required to meet the priority objectives. NFPA 1710 specifies that the number of on-duty fire suppression personnel must be sufficient to carry out the necessary fire fighting operations given the expected fire fighting conditions.*[2]

A response agency begins its critical task analysis by reviewing in detail an interior fire attack operation. In order to conduct an interior attack, responders are required to use of protective equipment, including turnout gear, SCBA (self-contained breathing apparatus) and an appropriate number of fire attack and exposure protection hose lines; additional personnel must be staged to perform rescue functions for interior fire fighting personnel, and a command structure must be in place. Since the establishment of OSHA 29 CFR 1910 (two-in/two-out

[2] Ibid.

standard), all agencies must have in place a rapid intervention capability readily able to rescue the total number of personnel operating within the structure. While other tasks may be done at different times, these functions must be in place prior to entry into the IDLH atmosphere.

Examples of individual critical tasks at structure fires are listed below. When assigning personnel to critical tasks, it is essential that adequate personnel be assigned to each function being performed simultaneously if incident objectives are to be accomplished.

Initial Attack Force (IAF) is the necessary personnel/tasks to begin the fire attack (four personnel minimum).

> Primary Attack Line - A medium-sized hose that produces 100+ gpm and is handled by a minimum of two firefighters, or a larger hose that produces 200+ gpm and is handled by three or more firefighters. Each engine carries a set of attack lines that are either pre-connected to the pump, folded on the hosebed, or in a special pack for carrying into high-rise buildings. The selection of which attack line to use depends on the type of structure, the distance to the seat of the fire, and the stage of the fire. The pre-connected lines are the fastest to use but are limited to fires within 200 feet of the pumper. When attack lines are needed beyond this limit, the hose bed lines or high-rise lines are used. A larger attack line will be used when the fire is already beyond the flashover stage and threatens an unburned portion of a structure. This team will also need to force entry and do some minor ventilation in order to advance the line.
>
> Pump Operator - One firefighter assigned to deliver water under the right pressure to the various hoselines in use (attack, backup and exposure lines), monitor the pressure changes caused by the changing flows on each line and ensure that a water hammer doesn't endanger any of the hoseline crews. This firefighter also completes the hose hookups to the correct discharges and completes the water supply hookup to the correct intake. The pump operator can sometimes make the hydrant hookup alone if the pumper is near a hydrant (50 feet), but the hydrant location sometimes precludes this.
>
> Rapid Intervention Crew (RIC) - A minimum of two firefighters equipped with self-contained breathing apparatus (SCBA), forcible entry tools, charged hoseline and thermal imaging camera assemble near the entry point to enter the structure and rescue the attack, search and rescue, or back up crew if something goes wrong. When the first four firefighters are on scene, the two outside firefighters are also known as the initial IRIC (Initial Rapid Intervention Team). One of the two personnel on the outside can be the pump operator if he/she is in close proximity to the entry point. When the balance of the effective response force arrives and interior fire attack is continuing in hazardous atmospheres and conditions, a full company is assigned to be the rapid intervention crew (RIC – Company Officer and three firefighters).

Command - An officer assigned to remain outside of the structure to coordinate the attack, evaluate results and redirect the attack, arrange for more resources, and monitor conditions that might jeopardize crew safety.

Effective Fire Force (EFF) is the number of personnel/tasks necessary to complete all of the critical action needed in the first stages of the emergency. The term Effective Response Force (ERF) is used interchangeablywith EFF in many publications.

Search and Rescue - A minimum of two firefighters assigned to search for living victims and remove them from danger while the attack crew moves between the victims and the fire to stop the fire from advancing on them. A two person crew is normally sufficient for most moderate risk structures, but more crews are required in multi-story buildings or structures with people who are not capable of self-preservation.

Ventilation - A minimum of two firefighters to open a horizontal or vertical ventilation channel when the attack crew is ready to enter the building. Vertical ventilation or ventilation of a multi-story building can require more than two firefighters. Ventilation removes superheated gases and obscuring smoke, preventing flashover and allowing attack crews to see and work closer to the seat of the fire. It also gives the fire an exit route so the attack crew can "push" the fire out the opening they choose and keep it away from endangered people or unburned property. Ventilation must be closely timed with the fire attack. If it is performed too soon, the fire will get additional oxygen and grow. If performed too late, the attack crew cannot push the fire in the direction they want. Instead, the gases and smoke will be forced back toward the firefighters and their entry point, which endangers them, any victims they are protecting, and unburned property.

Exposure Line - Any sized attack line or master stream appliance staffed by two or more firefighters and taken above the fire in multi-story buildings to prevent fire expansion. It can also be used externally to protect nearby structures from igniting from the radiant heat.

Secure Utilities – Electricity, gas and eventually water must be secured for the safety of the entry crews. This can normally be accomplished from outside of the IDLH and can sometimes be accomplished by a single person.

NFPA 1710 Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments (2010 edition) indicates that the number of on-duty fire suppression personnel shall be sufficient to perform the necessary firefighting operations given the expected firefighting conditions. It further states that these numbers shall be determined through task analyses that take the following factors into consideration:

(1) Life hazard to the populace protected.
(2) Provisions of safe and effective fire-fighting performance conditions for the firefighters.
(3) Potential property loss.
(4) Nature, configuration, hazards, and internal protection of the properties involved.

(5) Types of fireground tactics and evolutions employed as standard procedure, type of apparatus used, and results expected to be obtained at the fire scene.

NFPA 1710 requires a minimum fireground staffing of 14/15 personnel on a typical 2000 sq. ft. single-family dwelling. Minimum staffing should be:

Figure 52: Minimum Fireground Staffing

Task	Personnel
Incident command	1
Establishment of an uninterrupted water supply	1
Establishment of an effective water flow from two handlines	4
Support person for each attack and backup line	2
Search and rescue team	2
Raise ground ladders and perform ventilation	2
IRIC	2
Total without Aerial Operation	**14**
Dedicated aerial operator if aerial is used	1
Total with Aerial Operation	**15**

Regardless of the study conducted, the same basic tasks are used. These are the critical path items that must be accomplished in order to successfully combat a structure fire and rescue victim from harm's way.

NIST Study – April 2010

The National Institute of Standards and Technology (NIST), a part of U.S. Department of Commerce, published the *Report on Residential Fireground Field Experiments* in April of 2010. The Abstract and Conclusion from that report appear below:

> **Abstract**
> Service expectations placed on the fire service, including Emergency Medical Services (EMS), response to natural disasters, hazardous materials incidents, and acts of terrorism, have steadily increased. However, local decision-makers are challenged to balance these community service expectations with finite resources without a solid technical foundation for evaluating the impact of staffing and deployment decisions on the safety of the public and firefighters.
>
> For the first time, this study investigates the effect of varying crew size, first apparatus arrival time, and response time on firefighter safety, overall task completion, and interior residential tenability using realistic residential fires. This study is also unique because of the array of stakeholders and the caliber of technical experts involved. Additionally, the structure used in the field experiments included customized instrumentation; all related industry standards were followed; and robust research methods were used. The results and conclusions will directly inform the NPFA 1710 Technical Committee, who is responsible for developing consensus industry deployment standards.

This report presents the results of more than 60 laboratory and residential fireground experiments designed to quantify the effects of various fire department deployment configurations on the most common type of fire—a low hazard residential structure fire. For the fireground experiments, a 2,000 sq ft (186 m2), two-story residential structure was designed and built at the Montgomery County Public Safety Training Academy in Rockville, MD. Fire crews from Montgomery County, MD and Fairfax County, VA were deployed in response to live fires within this facility. In addition to systematically controlling for the arrival times of the first and subsequent fire apparatus, crew size was varied to consider two-, three-, four-, and five-person staffing.

Each deployment performed a series of 22 tasks that were timed, while the thermal and toxic environment inside the structure was measured. Additional experiments with larger fuel loads as well as fire modeling produced additional insight. Report results quantify the effectiveness of crew size, first-due engine arrival time, and apparatus arrival stagger on the duration and time to completion of the key 22 fireground tasks and the effect on occupant and firefighter safety.

Conclusion

More than 60 full-scale fire experiments were conducted to determine the impact of crew size, first-due engine arrival time, and subsequent apparatus arrival times on firefighter safety and effectiveness at a low-hazard residential structure fire. This report quantifies the effects of changes to staffing and arrival times for residential firefighting operations. While resource deployment is addressed in the context of a single structure type and risk level, it is recognized that public policy decisions regarding the cost-benefit of specific deployment decisions are a function of many other factors including geography, local risks and hazards, available resources, as well as community expectations. This report does not specifically address these other factors.

The results of these field experiments contribute significant knowledge to the fire service industry. First, the results provide a quantitative basis for the effectiveness of four-person crews for low-hazard response in *NFPA 1710*. The results also provide valid measures of total effective response force assembly on scene for fireground operations, as well as the expected performance time-to-critical-task measures for low-hazard structure fires. Additionally, the results provide tenability measures associated with a range of modeled fires.

Future research should extend the findings of this report in order to quantify the effects of crew size and apparatus arrival times for moderate- and high-hazard events, such as fires in high-rise buildings, commercial properties, certain factories, or warehouse facilities, responses to large-scale non-fire incidents, or technical rescue operations.

The NIST study does a very good job of reviewing the previous work by others. A shorter version of that review is provided here:

In 1980, the Columbus Fire Division's report on firefighter effectiveness showed that for a predetermined number of personnel initially deployed to the scene of a fire, the proportion of incidents in which property loss exceeded $5,000 and horizontal fire spread of more than 25 sq ft (2.3 m^2) was significantly greater for crews whose numbers fell below the set thresholds of 15 total fireground personnel at residential fires and 23 at large-risk fires (Backoff 1980). The following year, repeated live experiments at a one-family residential site using modern apparatus and equipment demonstrated that larger units performed tasks and accomplished knockdown more quickly, ultimately resulting in a lower percentage of loss attributable to factors controlled by the fire department. The authors of this article highlighted that the fire company is the fire department's basic working unit and further emphasized the importance of establishing accurate and up-to-date performance measurements to help collect data and develop conclusive strategies to improve staffing and equipment utilization (Gerard 1981).

Subsequent reports from the United States Fire Administration (USFA) and several consulting firms continued to provide evidence for the effects of staffing on fire crews' ability to complete tasks involved in fire suppression efficiently and effectively. Citing a series of tests conducted in 1977 by the Dallas Fire Department that measured the time it took three-, four-, and five-person teams to advance a line and put water on a simulated fire at the rear of the third floor of an old school, officials from the USFA underscored that time-to-task completion and final level of physical exhaustion for crews markedly improved not after any one threshold, but with the addition of each new team member. This report went on to outline the manner in which simulated tests exemplify a clear-cut means to record and analyze the resources initially deployed and finally utilized at fire scenes (NFA 1981). A later publication detailing more Dallas Fire Department simulations—ninety-one runs each for a private residential fire, high-rise office fire, and apartment house fire—showed again that increased staffing levels greatly enhanced the coordination and effectiveness of crews' fire suppression efforts during a finite time span (McManis Associates 1984). Numerous studies of local departments have supported this conclusion using a diverse collection of data, including a report by the National Fire Academy (NFA) on fire department staffing in smaller communities, which showed that a company crew staffed with four firefighters could perform rescue of potential victims approximately 80 percent faster than a crew staffed with three firefighters (Morrison 1990).

During the same time period that the impact of staffing levels on fire operations was gaining attention, investigators began to question whether staffing levels could also be associated with the risk of firefighter injuries and the cost incurred as a result of such injuries at the fire scene. Initial results from the Columbus Fire Division showed that "firefighter injuries occurred more often when the total number of personnel on the fireground was less than 15 at residential fires and 23 at large-risk fires" (Backoff 1980), and mounting evidence has indicated that staffing levels are a fundamental health and safety issue for firefighters in addition to being a key determinant of immediate response capacity. One early analysis by the Seattle Fire Department for that city's Executive Board reviewed the average severity of injuries suffered by three-, four-, and five-person engine companies, with the finding that "the rate of firefighter injuries expressed as total hours of disability per hours of fireground exposure were 54 percent greater for engine companies staffed with 3 personnel when compared to those staffed with 4 firefighters, while companies staffed with 5 personnel had an injury rate that was only one-third that associated with four-person companies" (Cushman 1981). A joint report from the International Association of Fire Fighters (IAFF) and Johns Hopkins University concluded, after a comprehensive analysis of the minimum staffing levels and firefighter injury rates in U.S. cities with populations of 150,000 or more, that jurisdictions operating with crews of less than four firefighters had injury rates nearly twice the percentage of jurisdictions operating with crews of four-person crews or more (IAFF, JHU 1991).

More recent studies have continued to support the finding that staffing per piece of apparatus integrally affects the efficacy and safety of fire department personnel during emergency response and fire suppression. Two studies in particular demonstrate the consistency of these conclusions and the increasing level of detail and accuracy present in the most recent literature, by looking closely at the discrete tasks that could be safely and effectively performed by three- and four-person fire companies. After testing drills comprised of a series of common fireground tasks at several fire simulation sites, investigators from the Austin Fire Department assessed the physiological impact and injury rates among the variably staffed fire crews. In these simulations, an increase from a three- to four-person crew resulted in marked improvements in time-to-task completion or efficiency for the two-story residential fire drill, aerial ladder evolution, and high-rise fire drill, leading the researchers to conclude that loss of life and property increases when a sufficient number of personnel are not available to conduct the required tasks efficiently, independent of firefighter experience, preparation, or training. Reviews of injury reports by the Austin Fire Department furthermore revealed that the injury rate for three-person companies in the four years preceding the study was nearly one-and-a-half that of crews staffed with four or more personnel (Roberts 1993). In a sequence of similar tests, the Office of the Fire Marshal of Ontario, Canada likewise found that three-person fire companies were unable to safely perform deployment of backup protection lines, interior suppression or rescue operations, ventilation operations that required access to the roof of the involved structure, use of large hand-held hose lines, or establish a water supply from a static source without additional assistance and within the time limits of the study. Following these data, Fire Marshal officials noted that three-person crews were also at increased risk for exhaustion due to insufficient relief at fire scenes and made recommendations for the minimum staffing levels per apparatus necessary for suppression and rescue related tasks (Office of the Fire Marshal of Ontario 1993).

The most comprehensive contemporary studies on the implications of fire crew staffing now include much more accurate performance measures for tasks at the fireground, in addition to the basic metric of response time. They include environmental measures of performance, such as total water supply, which expand the potential for assessing the cost-effectiveness of staffing not only in terms of fireground personnel injury rates but also comparative resource expenditure required for fire suppression. Several examples from the early 1990s show investigators and independent fire departments beginning to gather the kind of specific, comprehensive data on staffing and fireground tasks such as those suggested and outlined in concurrent local government publications that dealt with management of fire services (Coleman 1988). A report by the Phoenix Fire Department laid out clear protocols for responding to structure fires and response evaluation in terms of staffing, objectives, task breakdowns, and times in addition to outlining the responsibilities of responding fire department members and the order in which they should be accomplished for a full-scale simulation activity (Phoenix 1991). One attempt to devise a prediction model for the effectiveness of manual fire suppression similarly reached beyond response time benchmarks to describe fire operations and the step-by-step actions of firefighters at incident scenes by delineating the time-to-task breakdowns for size-up, water supply, equipment selection, entry, locating the fire, and advancing hose lines, while also comparing the predicted time-to-task values with the actual times and total resources (Menker 1994). Two separate studies of local fire department performance, one from Taoyuan County in Taiwan and another from the London Fire Brigade, have drawn ties between fire crews' staffing levels and total water demand as the consequence of both response time and fire severity. Field data from Taoyuan County for cases of fire in commercial, business, hospital, and educational properties showed that the type of land use as well as response time had a significant impact on the water volume necessary for fire suppression, with the notable quantitative finding that the water supply required on-scene doubled when the fire department response increased by ten minutes (Chang 2005).

Response time as a predictor of residential fire outcomes has received less study than the effect of crew size. A Rand Institute study demonstrated a relationship between the distance the responding companies traveled and the physical property damage. This study showed that the fire severity increased with response distance, and therefore the magnitude of loss increased proportionally (Rand 1978). Using records from 307 fires in nonresidential buildings over a three-year period, investigators in the United Kingdom correspondingly found response time to have a significant impact on final fire area, which in turn was proportional to total water demand (Sardqvist 2000).

The following five pages are taken directly from the final report. They summarize the work done on the critical task analysis during the study. A similar process was conducted locally using Chula Vista equipment, personnel, and procedures. This was accomplished to validate the findings of the NIST study on a local basis and to show the differences, where found, that are unique to Chula Vista and the region. The NIST study was completed on the east coast where fire stations tend to be closer together and truck companies more prevalent. Two-person and five-person companies were not evaluated locally as two-person companies are not within the norm for southern California communities with a full-time professional fire department and five-person companies have all but disappeared across the nation.

Time-to-Task Experiments

On-Scene Fire Department Tasks

The on-scene fire department task part of the study focused on the tasks firefighters perform after they arrive on the scene of a low-hazard residential structure fire. A number of nationally recognized fire service experts were consulted during the development of the on-scene fire department tasks in order to ensure a broad applicability and appropriateness of the task distribution.[8] The experiments compared crew performance and workload for a typical fire fighting scenario using two-, three-, four-, and five-person crews. 24 total experiments were conducted to assess the time it took various crew sizes to complete the same tasks on technically similar fires in the same structure. In addition to crew sizes, the experiments assessed the effects of stagger between the arriving companies. Close stagger was defined as a 1-minute time difference in the arrival of each responding company. Far stagger was defined as a 2-minute time difference in the arrival of each responding company. One-minute and two-minute arrival stagger times were determined from analysis of deployment data from more than 300 U.S. fire departments responding to a survey of fire department operations conducted by the International Association of Fire Chiefs (IAFC) and the International Association of Fire Fighters (IAFF). Considering both crew size and company stagger there were eight experiments conducted in triplicate totaling twenty-four tests, as shown in the full replicate block in Table 1. A full replicate was completed in a randomized order (determined by randomization software) before a test configuration was repeated.

Crew Size	Apparatus Stagger
2 Person	Close Stagger (One minute)
3 Person	Close Stagger (One minute)
4 Person	Close Stagger (One minute)
5 Person	Close Stagger (One minute)
2 Person	Far Stagger (Two minutes)
3 Person	Far Stagger (Two minutes)
4 Person	Far Stagger (Two minutes)
5 Person	Far Stagger (Two minutes)

Table 1: Primary Variables for Time-to-Task Experiments

Crew Size

For each experiment, three engines, a ladder-truck and a battalion chief and an aide were dispatched to the scene of the residential structure fire. The crew sizes studied included two-, three-, four-, and five-person crews assigned to each engine and truck dispatched. Resultant on-scene staffing totals for each experiment follow: (FF = firefighter)

- Two Person crews = 8 FFs + Chief and Aide = 10 total on-scene
- Three Person crews = 12 FFs + Chief and Aide= 14 total on-scene
- Four Person crews = 16 FFs + Chief and Aide = 18 total on-scene
- Five Person crews = 20 FFs + Chief and Aide = 22 total on-scene[9]

Department Participation

The experiments were conducted in Montgomery County, MD at the Montgomery County Fire Rescue Training Academy during the months of January and February 2009. All experiments took place in daylight between 0800 hours and 1500 hours. Experiments were postponed for heavy rain, ice, or snow and rescheduled for a later date following other scheduled experiments.

Montgomery County (MD) and Fairfax County (VA) firefighters participated in the field experiments. Each day both departments committed three engines, a ladder truck and associated crews, as well as a battalion chief to the experiments. The two battalion chiefs, alternated between the roles of battalion chief and aide. Firefighters and officers were identified by participating departments and oriented to the experiments. Each experiment included engine crews, truck crews and command officers from each participating department. Participants varied with regard to age and experience. Crews that normally operated together as a company were kept intact for the experiments to assure typical operation for the crew during the scenarios. However, in all experiments crews were used from both departments, including engine crews, truck crews, and officers.

This allocation of resources made it possible to conduct back-to-back experiments by rotating firefighters between field work and rehabilitation areas.

Crew Orientation

All study participants were required to attend an orientation prior to the beginning of the experiments (see Figure 9, page 25). The orientations were used to explain experiment procedures, task flows, division of labor between crews, and milestone events in the scenario.

Daily orientations were conducted for all shifts to assure every participant attended. Orientations included a description of the overall study objectives as well as the actual experiments in which they would be involved. Per the requirements of *NFPA 1403*, full disclosure regarding the structure, the fire, and the tasks to be completed were provided. Crews were also oriented to the fireground props, instrumentation used for data collection, and the specific scenarios to be conducted. Every crew member was provided a walkthrough of the structure during the orientation and each day prior to the start of the experiments.

8 Technical experts included Dennis Compton, Russell Sanders, William "Shorty" Bryson, Vincent Dunn, David Rohr, Richard Bowers, Michael Clemens, James Walsh, Larry Jenkins and Doug Hinkle. More information about the experts is presented in the Acknowledgments later in this report.

9 Note that the on-scene totals account for only the personnel assigned to "work" the fire. Additional personnel were provided for an RIT team, a staffed ambulance on site, and a safety officer specific to the experiments. The additional personnel are not included in thee staffing described above.

24

Tasks

Twenty-two fireground tasks were completed in each experiment. Meticulous procedures gathered data to measure key areas of focus, such as individual task start times, task completion times, and overall scenario performance times. Each task was assigned a standardized start and end marker, such as crossing the threshold to enter the building with a hose line or touching a ladder to raise it to a second story window. The 22 tasks, with the events for measuring start and stop times, are shown in Table 2 (page26). Figures 10 — 19 illustrate firefighter activity in a number of the tasks to complete experiments or prepare for the next experiment.

For reasons of both safety and cost efficiency, two tasks — forcible entry of the front door and ventilation of the windows on the first and second stories — required special procedures. The study could not accommodate replacing the doors and windows daily for the fire suppression experiments. Before the start of experiments with the full sequence of tasks, these two tasks were measured in a realistic manner using training props constructed at the site of the fireground experiments. As with the overall experiments, these two tasks were repeated in triplicate and the times averaged. The average time to complete the tasks was then used in the larger scale experiment. As firefighters came to the point of breaching the door or windows, the timers would hold them for the time designated by the earlier experiments and then give them the approval to open the door or windows. The start and end times were then recorded just as other tasks were.

Figure 9: Crew Orientation and Walkthrough

Figure 10: Ground Ladders

Figure 11: Ventilation

Figure 12: Ground Level Window Breakage Prop

Figure 13: Second Story Window Breakage Prop

Figure 14: Door Forcible Entry Prop

Figure 15: Crew Preparation and Cue Cards

25

Table 2: Tasks and Measurement Parameters

Tasks	Measurement Parameters
1. Stop at Hydrant, Wrap Hose	START - Engine stopped at hydrant STOP - Firefighter back on engine and wheels rolling
2. Position Engine 1	START - Wheels rolling from hydrant STOP - Wheels stopped at structure
3. Conduct Size-up (360-degree lap), transmit report, establish command	START - Officer off engine STOP - Completes radio transmission of report
4. Engage Pump	START - Driver off engine STOP - Driver throttles up pump
5. Position Attack Line (Forward Lay)	START - Firefighter touches hose to pull it from engine STOP - Flake, charge and bleed complete (hose at front door prepared to advance)
6. Establish 2 In/2 Out	Company officer announces – "2 In/2 Out established" (4 persons assembled on scene OR at the call of the Battalion Chief/Company Officer)
7. Supply Attack Engine	START - Firefighter touches hydrant to attach line STOP - Water supply to attack engine
8. Establish RIT	Time that Company Officer announces RIT is established
9. Gain/Force Entry	START - Action started (HOLD time= 10 seconds) STOP - Door opened for entry
10. Advance Attack Line	START – Firefighter touches hose STOP – Water on fire
11. Advance Backup Line (stop time at front door)	START - Firefighter touches hose to pull from engine bed STOP - Backup line charged to nozzle
12. Advance Backup Line/Protect Stairwell	START - Firefighter crosses threshold STOP - Position line for attack at stairwell
13. Conduct Primary Search	START - Firefighters enter front door STOP - Firefighters transmit "search complete"
14. Ground Ladders in Place	START - Firefighter touches ladder to pull it from truck STOP - 4 Ladders thrown: 3 ladders on the 2nd-story windows and 1 to the roof
15. Horizontal Ventilation (Ground)	START- Firefighter at 1st window to begin ventilation (HOLD for 8 seconds) STOP - Hold time complete - window open
16. Horizontal Ventilation (2nd Story)	START - Firefighter grabs ladder for climb. (Firefighter must leg lock for ventilation. HOLD time at each window is 10 seconds) STOP - All 2nd-story windows open - descend ladder - feet on ground
17. Control Utilities (Interior)	START - Radio transmission to control utilities STOP - When firefighter completes the task at the prop
18. Control Utilities (Exterior)	START - Radio transmission to control utilities STOP - When firefighter completes the task at the prop
19. Conduct Secondary Search	START - Firefighters enter front door STOP - Firefighters transmit "secondary search complete"
20. Check for Fire Extension (walls)	START- Firefighters pick up check-for-extension prop STOP- Completion of 4 sets total (1 set = 4 in and 4 out) This task may be done by more than one person.
21. Check for Fire Extension (ceilings)	START - Firefighters pick up check-for-extension prop STOP - Completion of 4 sets total (1 set = 3 up and 5 down) This task may be done by more than one person.
22. Mechanical Ventilation	START - Firefighters touch fans to remove from truck STOP - Fans in place at front door and started

Data Collection: Standardized Control Measures

Several control measures were used to collect data, including crew cue cards, radio communications, task timers, and video recording. Performance was timed for each task in each scenario including selected milestone tasks such as door breach, water-on-fire, and individual window ventilation. Data were collected for crew performance on each task, and individual firefighter performance was not considered.

Task Flow Charts and Crew Cue Cards

Task procedures were standardized for each experiment/scenario. Technical experts worked with study investigators to break down crew tasks into individual tasks based on crew size. Task flow charts were created and then customized for the various crew sizes. The carefully designed task flow ensured that the same overall workload was maintained in each experiment, but was redistributed based on the number of personnel available for the work. See Appendix D for additional details.

All tasks were included in each scenario and cue cards were developed for each individual participant in each scenario. For example, a four-person crew would have a cue card for each person on the crew including the officer, the driver, and the two firefighters. Cards were color coded by crew size to assure proper use in each scenario.


Figure 16: Connecting to the Hydrant


Figure 17: Crews Responding


Figure 18: Ceiling Breach/Molitor Machine


Figure 19: Incident Command


Figure 20: Task Timers


Figure 21: Video Recording for Quality Control

Radio communications

Interoperability of radio equipment used by both participating departments made it possible to use regular duty radios for communication during the experiments. Company officers were instructed to use radios as they would in an actual incident. Montgomery County Fire and Rescue Communications recorded all radio interaction as a means of data backup. Once all data quality control measure were complete, the records were then overwritten as a routine procedure.

Task Timers

Ten observers/timers, trained in the use of a standard stop watch with split-time feature, recorded time-to-task data for each field experiment. To assure understanding of the observed tasks, firefighters were used as timers, each assigned specific tasks to observe and to record the start and end times.

To enhance accuracy and consistency in recording times, the data recording sheets used several different colors for the tasks (see Appendix D). Each timer was assigned tasks that were coded in the same color as on the recording sheet. All timers wore high-visibility safety gear on the fireground (see Figure 20).

Video records

In addition to the timers, video documentation provided a backup for timed tasks and for quality control (see Figure 21). No less than six cameras were used to record fireground activity from varied vantage points. Observer/timer data were compared to video records as part of the quality control process.

27

Crew Assignment

Crews from each department that regularly operated together were assigned to work as either engine or truck companies in each scenario. Both Fairfax County and Montgomery County crews participated in each experiment.

Crews assigned to each responding company position in one scenario were assigned to another responding company position in subsequent scenarios, with the objective of minimizing learning from one experiment to another. For example, crews in the role of engine 1 in a morning scenario might be assigned to the engine 3 position in the afternoon, thus eliminating learning from exact repetition of a task as a factor in time to completion. Additionally, participating crews from both Montgomery County and Fairfax County were from three different shifts, further reducing opportunities for participant repetition in any one position.

Response Time Assumptions

Response time assumptions were made based on time objectives set forth in the *NFPA 1710*. Time stagger allocations were set by the project technical advisors in order to assess the impact of arriving unit time separation on task start and completion times, as well as the overall scene time.

Below are the values assigned to the various time segments in the overall response time. The total of the response time segments may also be referred to as the total reflex time.

1. Fire ignition = time zero
2. 60 s for recognition (detection of fire) and call to 9-1-1
3. 60 s for call processing/dispatch
4. 60 s for turnout[10]
5. Close Stagger = 240 s travel time FIRST engine with 60 s ladder-truck lag and 90 s lag for each subsequent engine
   a. Truck arrives at 300 s from notification
   b. Second engine at 330 s from notification
   c. Third engine at 420 seconds from notification
6. Far Stagger = 240 s travel time FIRST engine with 120 s ladder-truck lag and 150 s lag for each subsequent engine
   a. Truck arrives at 360 s from notification
   b. Second engine arrives at 390 s from notification
   c. Third engine arrives at 540 s from notification.

The design of this part of the experiments allowed firefighter entry into the burn building. The next part of the experiments required a modified methodology.

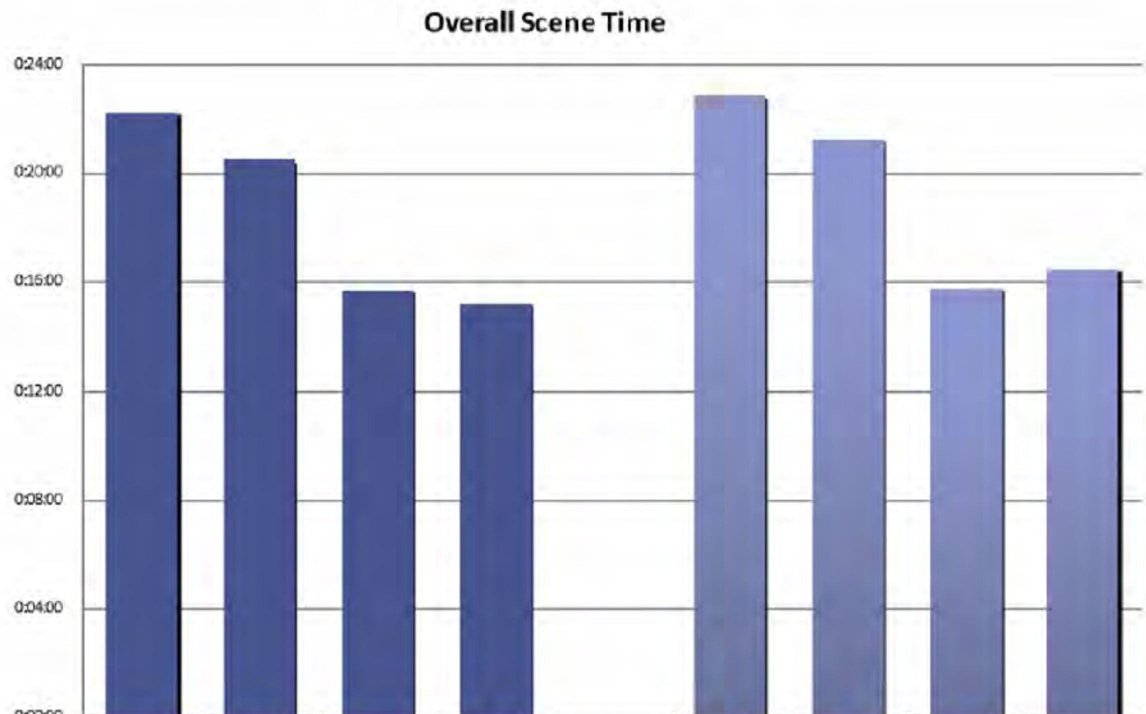
10 After the experiments were complete, the NFPA 1710 technical committee released a new edition of the standard that prescribes 80 seconds for turnout time.

28

NIST Study Conclusions (Summarized)

Overall Scene Time:
The four-person crews completed the same number of fireground tasks (on average) 5.1 minutes faster — nearly 25 percent — than the three-person crew.

Figure 53: NIST Overall Scene Time



	2-Person Close	3-Person Close	4-Person Close	5-Person Close		2-Person Far	3-Person Far	4-Person Far	5-Person Far
End Time	0:22:16	0:20:30	0:15:44	0:15:13		0:22:52	0:21:17	0:15:48	0:16:31
Start Time	0:00:00	0:00:00	0:00:00	0:00:00		0:00:00	0:00:00	0:00:00	0:00:00

Time to Water on Fire:
There was a 6 percent difference in the “water on fire time” between the three and four-person crews.

Ground Ladders and Ventilation:
The four-person crew operating on a low-hazard structure fire can complete laddering and ventilation (for life safety and rescue) 25 percent faster than the three-person crew.

Primary Search:
The four-person crews started and completed a primary search 6 percent faster than the three-person. A 10 percent difference was equivalent to just over one minute.

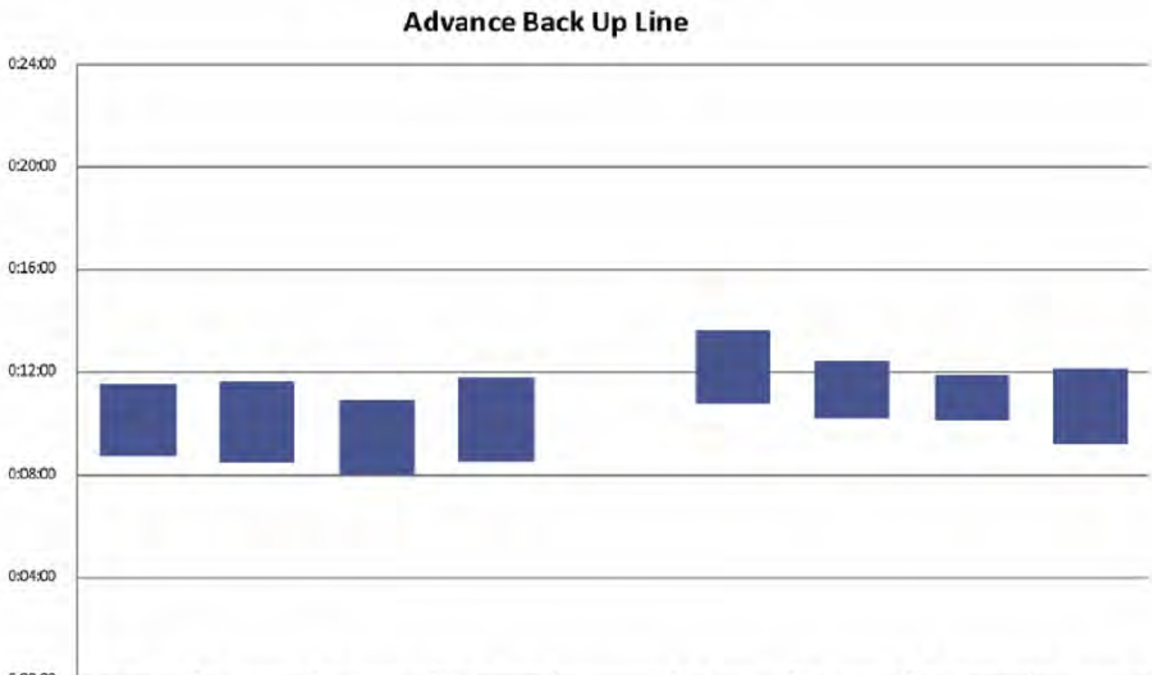
Hose Stretch Time:

In comparing four-person crews to three-person crews, the time difference to stretch a line was 34 seconds. This is not significant and this task does normally take more than one person to accomplish.

Advancing a Backup Line

Advancing a backup line to the door and stairwell was started 16 percent faster and completed 9 percent faster for replicates with shorter staggers between company arrivals. Advancing a backup line is typically a task completed by the third arriving engine on a full alarm assignment and is critical to the safety of firefighters already in the building on the initial attack line. For this task, stagger of arrival was statistically significant and is an important consideration for overall station location and full alarm response capability. The differences can be seen in the time from the start for the task "Deploy Backup Line" to the end of the task "Advance Backup Line."

Figure 54: NIST Advance Back Up Line



	2-Person Close	3-Person Close	4-Person Close	5-Person Close		2-Person Far	3-Person Far	4-Person Far	5-Person Far
End Time	0:11:28	0:11:33	0:10:55	0:11:48		0:13:37	0:12:23	0:11:54	0:12:04
Duration	0:02:34	0:02:58	0:02:46	0:03:09		0:02:45	0:02:04	0:01:41	0:02:44
Start Time	0:08:54	0:08:35	0:08:08	0:08:39		0:10:52	0:10:19	0:10:13	0:09:20

Industry Standard Achieved:

The "industry standard achieved" time started from the first engine arrival at the hydrant and ended when 15 firefighters were assembled on scene. An effective response force was assembled by the five-person crews three minutes faster than the four-person crews. According to study deployment protocol, the two- and three-person crews were unable to assemble enough personnel to meet the *NFPA 1710* standard.

Occupant Rescue:
Three different "standard" fires (slow-, medium-, and fast-growth rate) were simulated using the Fire Dynamics Simulator (FDS) model. The fires grew exponentially with time. The fire modeling simulations demonstrated that, late arriving crews can face a fire that is twice the intensity of the fire faced by, early arriving crews. The rescue scenario was based on a non-ambulatory occupant in an upstairs bedroom with the bedroom door open. Independent of fire size, there was a significant difference between the toxicity, expressed as fractional effective dose (FED), for occupants at the time of rescue depending on arrival times for all crew sizes. Occupants rescued by crews starting tasks two minutes earlier had less exposure to combustion products.

Local Critical Staffing Analysis

Chula Vista Fire Department conducted a Critical Task Analysis of a moderate risk structure fire using three engines, one truck, and one battalion chief, just as in the NIST study. The two variables used were selected to demonstrate two aspects of the critical task analysis that differ from the NIST study. First is the arrival time for the second unit. The NIST study had the truck company arriving second, which is not the case most often in Chula Vista unless the fire is in FS01's or FS07's first due area. In those cases, the truck would typically arrive with the first due engine. In addition to bringing in the truck early, the stagger times used were one minute and two minutes in the NIST study while Chula Vista's times are nearly twice that due to the distance between fire stations (especially on the eastside). The analysis was conducted using arrival times from the 2009 emergency responses dataset.

Figure 55: Chula Vista CTA Timeframes

	Average	80th percentile	90th percentile
Second Engine arrival	1:45	3:06	3:49
Third Engine arrival	5:21	-	-
Truck arrival	4:22	-	-
Battalion Chief arrival	4:22	-	-

Above are elapsed time from arrival of the first engine

The arrival of the second engine for the CVFD study was staggered at the average, 80th percentile, and 90th percentile while all other units were kept to the average. This allowed the isolation of this variable for analysis.

The second variable is the CVFD study was staffing (number of firefighters). CVFD runs three-person engines and four-person truck companies. As with the NIST study, CVFD wanted to see the impact of having additional personnel who arrived in a more timely manner (referred to as a "heavy response"). Additional personnel in the early minutes of a fire fight can make a huge difference in the outcome. This was proven in the NIST study and CVFD wanted to see the impacts of a "heavy response" on operations within its own organization.

In order to evaluate the impacts objectively, fireground evolutions were conducted. Each scenario (average, 80th percentile, and 90th percentile) were run with three different configurations: All engines with three-person crews, a single four-person crew on the first arriving unit with all other having three personnel, and all engines with four-person crews. Each configuration was evaluated a minimum of three times (27 evolutions minimum). The evolutions were conducted over three days using all three shifts.

For this analysis, no smoke was used but the threshold of the doorway to the building was considered to be IDLH and required full SCBA (actually breathing air from the SCBA) and full PPE to proceed beyond this point.

Figure 56: CTA Fireground Evaluations

Markers were placed at specific locations to have units stop at the same location each time. Each group completed the evolutions several times over the course of the morning/afternoon that they were assigned to the study.

Figure 57: CTA Fireground Evaluations

After each evolution, all personnel quickly readied the apparatus for the next evolution.

Figure 58: CTA Fireground Evaluations, continued

In the CVFD study, the first engine stopped at a fire hydrant, laid a supply to the building, pulled the 150' preconnect ($1^3/_4$" hose) and advanced it to the entry door. At this point, they simulated forcible entry and were allowed to enter when an RIC was in place, all personnel had PPE on and they were breathing air from their SCBAs. The second engine assumed command, pulled the RIC line if this was not already done and staffed/augmented the RIC. The second engine assisted with moving hose into the building and if manpower allowed, secured utilities. As soon as the truck company arrived, they placed ground ladders on two sides of the structure and took tools aloft to cut a ventilation hole over the fire. If utilities had not been shut off when they arrived, they accomplished this as well. A second attack line was placed into service as manpower allowed (but always when the third engine arrived).

Figure 59: CTA Fireground Evaluations

Evaluators had check lists with the major milestones. Five evaluators were placed around the drill grounds and each kept times for every milestone that they witnessed. Stop watches were synchronized at the start of each evolution.

Times from all five evaluators were averaged into the times for that evolution. Times from the three or more evolutions in that scenario were then averaged into a time for that configuration. The results were then graphed to show the impacts of arrival time and staffing on the fireground tasks that had been measured in the evolutions.

The graphs shown in Figure 60 and Figure 61 clearly show the difference in elapsed time for crews arriving with three personnel vs. four personnel. In both graphs, the red line shows the performance for three-person crews. Green shows the first unit arriving with four personnel and the balance of the assignment had three-person engines. Finally, the blue line shows four personnel on every unit.

Several key issues are illustrated on the graphs. First, water on the fire occurred almost twice as fast (3:04 faster). As noted from the NIST fire test, "*The fire modeling simulations demonstrated that, late arriving crews can face a fire that is twice the intensity of the fire faced by, early arriving crews.*" This is significant. The four-person crew had the first attack line in place faster but even more importantly, they were able to get the backup line for the RIC in place and the RIC itself so that the entry crew could proceed as soon as they were ready.

Figure 60: CVFD Critical Task Analysis

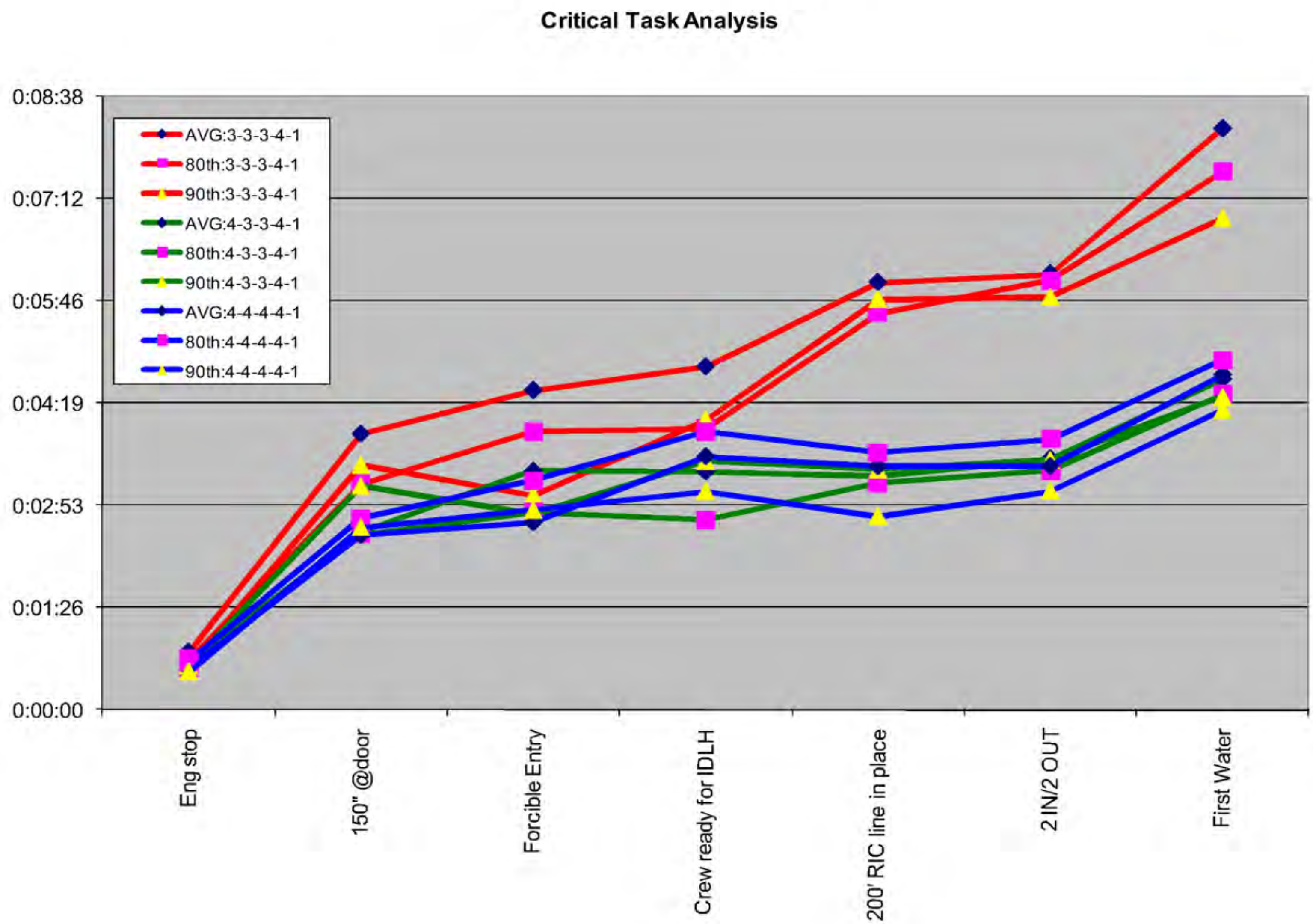


Figure 61: CVFD Critical Task Analysis - Simplified

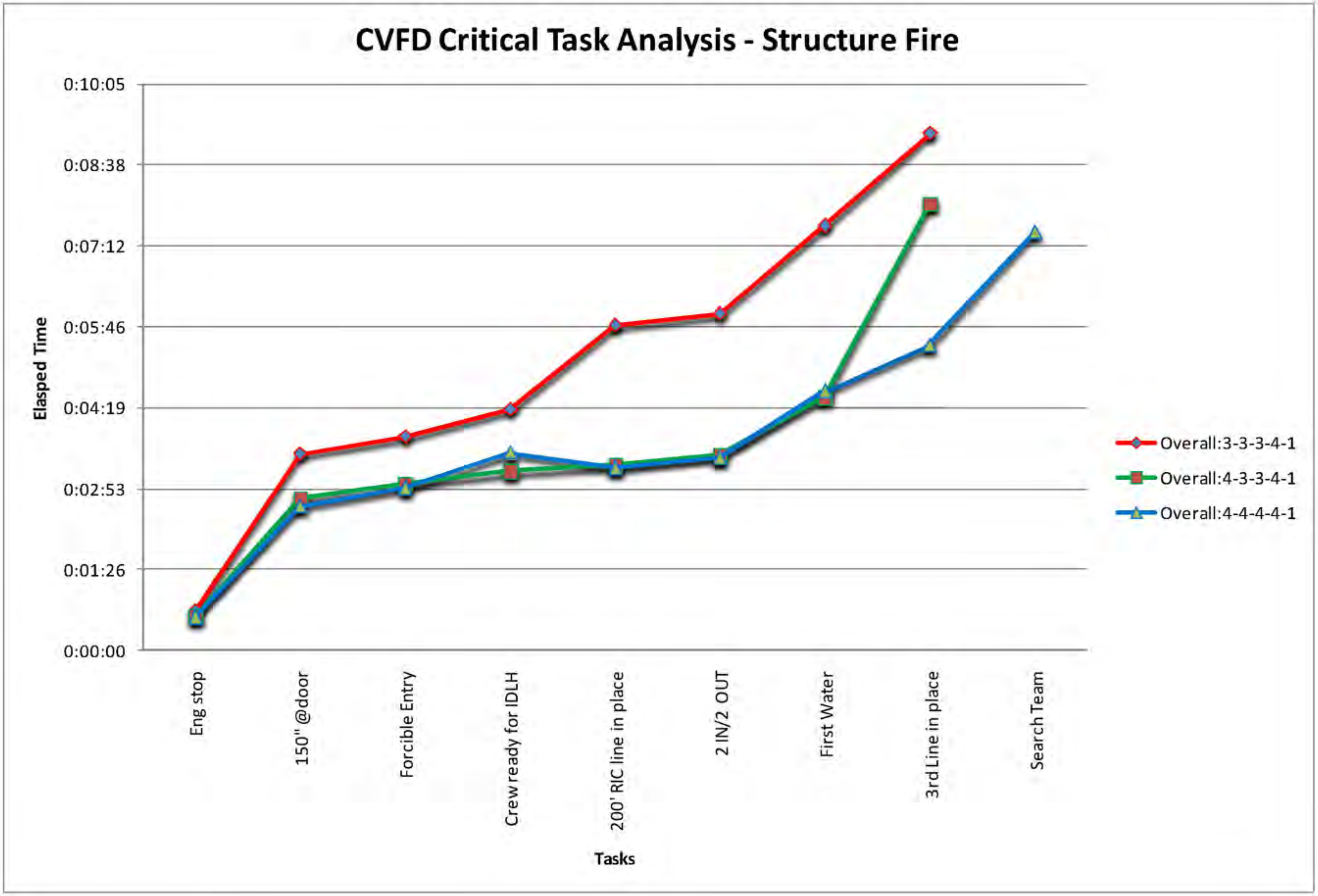


Figure 62: CVFD Critical Task Results

	Eng stop	150" @door	Forcible Entry	Crew ready for IDLH	200' RIC line in place	2 IN/2 OUT	First Water	3rd Line in place	Search Team	Ladders: 2 ground in place	Utilities	Ventilation
Overall:3-3-3-4-1	0:00:43	0:03:30	0:03:49	0:04:18	0:05:48	0:06:00	0:07:34	0:09:13		0:06:33	0:06:40	0:07:24
Overall:4-3-3-4-1	0:00:37	0:02:43	0:02:58	0:03:11	0:03:18	0:03:29	0:04:30	0:07:57		0:06:04	0:05:21	0:06:59
Overall:4-4-4-4-1	0:00:36	0:02:35	0:02:54	0:03:31	0:03:15	0:03:26	0:04:37	0:05:27	0:07:27	0:06:11	0:05:05	0:07:04
3 vs 4 fist arrival	0:00:06	0:00:48	0:00:51	0:01:07	0:02:30	0:02:32	0:03:04	0:01:16		0:00:29	0:01:19	0:00:25
3 vs 4 all units	0:00:07	0:00:56	0:00:55	0:00:47	0:02:32	0:02:34	0:02:57	0:03:46		0:00:22	0:01:36	0:00:20

In the preceding chart, the additional efficiency of the fourth person on the crew is clearly demonstrated. The four-person crew (first engine) clearly makes a difference in getting the first hose line to the entry point and forcing the door, but the performance gap increases significantly when the four-person crew is able to get the RIC line and RIC in place nearly twice as fast (2:30 vs. 6:00). This difference is increased to three minutes by the time the crew is applying water to the fire.

Three other issues are clearly demonstrated as well. First, is the securing of utilities (an important safety factor for firefighting crews); this occurred at least 90 seconds sooner. Second is the third line (second attack line), which was improved by the additional staffing on the first unit but increased again with the additional staffing on the second unit. This time was nearly cut in half and dramatically increased both fire flow (ability to combat the fire) and firefighter safety (in the event that something should happen to the first line). Finally, only the all four-person staffing configuration was capable of providing a dedicated search and rescue team to the interior of the structure from the first alarm assignment (Figure 61).

CTA Summary

The 1984 Dallas Fire Department Study's conclusion on three-person crews bears repeating:

> *The three-person crew was able to control the fire although they were unable to complete the search of the lower level until after the fire was extinguished. At this staffing level, there was little margin for error and any appreciable delay in arrival might place the control of the fire beyond their capability.*

Three-person crews can and do function on firegrounds all over the United States. The issues related to crew size are about safety (the public and firefighters) and the fire department's ability to perform in a manner that limits damage, saves lives, and protects the community to the level that the community expects. Four-person crews are more efficient. This has been demonstrated in several studies. Chula Vista Fire Department validated the national studies by completing a CTA with local personnel, equipment, and procedures. The results were similar but more pronounced due to the spacing of the fire stations in Chula Vista versus the one-minute timeframes used in the national studies.

The issue of three versus four personnel on a unit is not specifically about how many personnel ride on a particular apparatus. It is about the number of personnel who arrive within a particular timeframe. The issue of a "heavy response" is key. A "heavy response" can be increased in one of three ways:

1. Increased staffing on apparatus
2. Decreased distance between fire stations
3. Additional apparatus in each fire station

Amongst the options above, increased staffing on apparatus is the most cost effective.

The fire department expends over 85 percent of its time on emergency call providing emergency medical services (EMS). Staffing for EMS was also examined by NIST. The following is the conclusion from that study published in 2010:

> *The objective of the experiments was to determine how first responder crew size, ALS provider placement, and the number of ALS providers is associated with the effectiveness of EMS providers. EMS crew effectiveness was measured by task intervention times in three scenarios including patient access and removal, trauma, and cardiac arrest. The results were evaluated from the perspective of firefighter and paramedic safety and scene efficiency rather than as a series of distinct tasks. More than 100 full-scale EMS experiments were conducted for this study.*
>
> *As noted in the literature review, hundreds of firefighters and paramedics are injured annually on EMS responses. Most injuries occur during tasks that require lifting or abnormal movement by rescuers. Such tasks include lifting heavy objects (including human bodies both conscious and unconscious), manipulating injured body parts and carrying heavy equipment. Several tasks included in the experiments fall into this category, including splinting extremities, spinal immobilization (back boarding) and patient packaging. During the experiments larger crews completed these tasks more efficiently by distributing the workload among more people thereby reducing the likelihood of injury.*
>
> *A number of tasks are also labor intensive. These tasks can be completed more efficiently when handled by multiple responders. Several tasks in the experiments are in this category. These include checking vital signs, splinting extremities, intubation with spinal restriction, establishing IV access spinal immobilization, and patient packaging. Similar to the lifting or heavy work load task, larger crews were able to complete labor intensive tasks using multiple crew members on a single task to assure safe procedures were used reducing the likelihood of injury or exposure.*
>
> *Finally, there are opportunities on an EMS scene to reduce scene time by completing tasks simultaneously rather than concurrently thus increasing operational efficiency. Since crews were required to complete all tasks in each scenario regardless of their crew size or configuration, overall scene times reveal operational efficiencies.*
>
> *Each of these perspectives is discussed below for the patient access/removal scenario, as well as both the trauma and the cardiac scenarios.*

Patient Access and Removal

With regard to accessing the patient, crews with three or four first responders reached the patient around half a minute faster than smaller crews with two first responders. With regard to completing patient removal, larger first responder crews in conjunction with a two-person ambulance were more time efficient. The removal tasks require heavy lifting and are labor intensive. The tasks also involve descending stairs while carrying a patient, carrying all equipment down stairs, and getting patient and equipment out multiple doors, onto a stretcher and into an ambulance.

The patient removal results show substantial differences associated with crew size. Crews with three- or four-person first responders complete removal between (1.2 – 1.5) minutes faster than smaller crews with two first responders. All crews with first responders complete removal substantially faster (by 2.6 min. - 4.1 min.) than the ambulance-only crew.

These results suggest that time efficiency in access and removal can be achieved by deploying three-or four-person crews on the first responding engine (relative to a first responder crew of two). To the extent that each second counts in an EMS response, these staffing features deserve consideration. Though these results establish a technical basis for the effectiveness of first responder crews and specific ALS crew configurations, other factors contributing to policy decisions are not addressed.

Trauma

Overall, field experiments reveal that four-person first responder crews completed a trauma response faster than smaller crews. Towards the latter part of the task response sequence, four-person crews start tasks significantly sooner than smaller crews.

Additionally, crews with one ALS provider on the engine and one on the ambulance completed all tasks faster and started later tasks sooner than crews with two ALS providers on the ambulance. This suggests that getting ALS personnel to the site sooner matters.

A review of the patterns of significant results for task start times reinforced these findings and suggests that (in general) small non-significant reductions in task timings accrue through the task sequence to produce significantly shorter start times for the last third of the trauma tasks.

Finally, when assessing crews for their ability to increase on-scene operational efficiency by completing tasks simultaneously, crews with an ALS provider on the engine and one ALS provider on the ambulance completed all required tasks 2.3 minutes (2 minutes 15 seconds) faster than crews with a BLS engine and two ALS providers on the ambulance. Additionally, first responders with four-person first responder crews completed all required tasks 1.7 minutes (1 minute 45 seconds) faster than three-person crews and 3.4 minutes (3 minutes and 25 seconds) faster than two-person crews.

Cardiac

The overall results for cardiac echo those of trauma. Regardless of ALS configuration, crews responding with four first responders completed all cardiac tasks (from at-patient to packaging) more quickly than smaller first responder crew sizes. Moreover, in the critical period following cardiac arrest, crews responding with four first responders also completed all tasks more quickly than smaller crew sizes. As noted in the trauma scenario, crew size matters in the cardiac response.

Considering ALS placement, crews responding with one ALS provider on both the engine and ambulance completed all scene tasks (from at-patient to packaging) more quickly than a crew with a BLS engine and two ALS providers on the ambulance. This suggests that ALS placement can make a difference in response efficiency. One curious finding was that crews responding with a BLS engine and an ambulance with two ALS providers completed the tasks that follow cardiac arrest 50 seconds sooner than crews with an ALS provider on both the engine and ambulance. As noted, this counter-intuitive difference in the results may be attributable to the delay of the patient arrest time based on the arrival of the 12-Lead ECG monitor with the two-person ALS Ambulance crew. The 12 -Lead ECG task end time was the arrest start time. In this scenario, there were instantaneously two ALS providers present at the arrest rather than the one ALS provider placing the 12-Lead ECG device in the ALS engine /ALS Ambulance crew.

A review of the patterns of significant results across task start times showed mixed results. An ALS on an engine showed an advantage (sooner task starting times) over an ALS on an ambulance for a few tasks located earlier in the cardiac response sequence (specifically, ALS Vitals 12-Lead through IV access). A crew size of four also showed shorter start times for a few early tasks in the cardiac response sequence (initial ABC's, and the ALS Vitals 12-Lead and expose chest sequence). More importantly, a sequential time advantage appears for the last three tasks of the sequence (analyze shock #2 through package patient).

Finally, when assessing crews for their ability to increase on-scene operational efficiency by completing tasks simultaneously, crews with an ALS provider on the engine and one ALS provider on the ambulance completed all required tasks 45 seconds faster than crews with a BLS engine and two ALS providers on the ambulance. Regardless of ALS configuration, crews responding with four first responders completed all cardiac tasks from the "at patient time" to completion of packaging 70 seconds faster than first responder crews with three persons, and two minutes and 40 seconds faster than first responder crews with two persons. Additionally, after the patient arrested, an assessment of time to complete remaining tasks revealed that first responders with four-person crews completed all required tasks 50 seconds faster than three-person crews and 1.4 minutes (1 minute 25 seconds) faster than two-person crews.

In another study, *Initial Attack Effectiveness: Wildland Staffing Study, 2010*, (San Diego State University, Matt Rahn, Ph.D.) staffing on wildland incidents, as they apply to the initial attack phase, were conducted and the following is the conclusion for that study:

The results from this study unequivocally show that lower levels of staffing result in higher physical stress and significantly lower efficiencies for initial attack effectiveness. The most dramatic gains in efficiency, and decreases in stress occurred when firefighters on a hose lay were increased from 2- to 3-firefighters. Additional increases were observed when comparing 3- to 4-person crews, while very slight increases were observed when comparing 4- to 5-person crews.

From an economic perspective, the most efficient and beneficial change would be to increase staffing levels from two- to three-firefighter crews available for actual hose-lays and firefighting. On a typical engine, this would mean that there should be a minimum of three firefighters, and one company officer. The officer is not actively engaged in laying hose, but is instead responsible for the tactical command of the fire: giving orders, planning tactics, managing the engine, and ensuring the safety of the firefighters. What his study suggests is that the efficiency and safety of our firefighters requires a minimum

> *increase in year-round staffing from 3.0 to 4.0 (using the historic terminology of engine staffing levels).*
>
> *Therefore, providing four staff per engine would provide the most significant potential gains in initial attack effectiveness and overall efficiency. Recall, the intensity and size of wildland fires have dramatically increased in the past decade; lower staffing levels may be unable to adequately respond to modern wildfire events.*
>
> *This is of paramount importance to the safety and security of California. Even seemingly minor decreases in wildfire impacts can result in significant economic savings. For example, if the devastating 2003 wildfires in San Diego County were decreased by only 1% to 10%, the region could have experienced an economic savings of between $25,000,000 to $250,000,000 (respectively).*

The overwhelming conclusion from all three of these studies is that crew size has a direct relationship to the time it takes to complete critical tasks on the emergency scene. Time is the determination of success and failure in fire and EMS calls. Quicker suppression of fires keeps them smaller with less damage and limits the possibility of harm to the citizens and their homes. Time in nearly all critical care EMS calls is the one common denominator that has a direct relationship with outcomes for patients. The sooner a patient receives the proper care (in the field or hospital), the more likely the patient will have a positive outcome.

In all three studies (Structural Firefighting, Wildland Firefighting, and Emergency Medical Services), staffing of four personnel was optimal and provided significant increases in efficiency for the emergency crew while increasing safety to the responders and victims alike.

Task 4 – Deployment Issues/Opportunities

It should be understood that modeling has its limitations. Performance is modeled based on actual performance, but modeling cannot take into account all of the variables that occur in real life. In modeling, the calculation is linear, and does not have anomaly or artifact in it. For this reason, some of the performances will be slightly different than the actual performance results when viewed at the micro-level. The real value in modeling is to compare one set of calculations to another to see the net effect of the change. The models in this analysis were validated with actual performance values.

Using current performance, risks, and growth expectations, it is possible to model predicted performance of the delivery system. One factor that needs to be understood in this process is that modeling is only as good as the data that is provided. In this case, input data on calls has been developed over a four-year period. Changes in the deployment system, data fields, and dispatch centers have cause some data anomaly and have reduced the ability to compare some data directly with years past. For the most part, this is statistically insignificant at a systems level but does become more significant when viewed at the district or incident level.

The emergencies call database has four years of data and over 76,000 calls for service within it. When looking at specific subgroups such as structure fires, the database is still smaller and reduces the level of confidence in some aspects of the performance. This being said, the majority of the modeling has been done using the larger database for basic distribution, and the subgroups only used when the entire database would not be appropriate. Each year, the CVFD has been able to add to the database and re-analyze performance projections to increase the level of confidence and to validate current conclusions and recommendations. While some small shifts are to be expected, large changes in the underlying assumptions are not anticipated.

While it was covered in detail previously, it bears repeating that some of the assumptions, performance measures and modeling inputs have changed since the 2006 report. Briefly, the differences are:

1. Travel Time/IAF/EFF are being used as the primary Measures of Performance for this update. One significant change is that EFF now measures 14 FF and 1 engine company whereas the previous report used 14 FF, 3 engines, 1 truck, and 1 battalion chief to stop the clock on the performance measure.

2. Use of AMR to stop clock on first unit for EMS calls. In the previous report (2006) ambulances were not tracked; data was not available and they were simply not considered.
3. Model changes have been made. The most significant is the use of speed limits as opposed to an average travel speed.

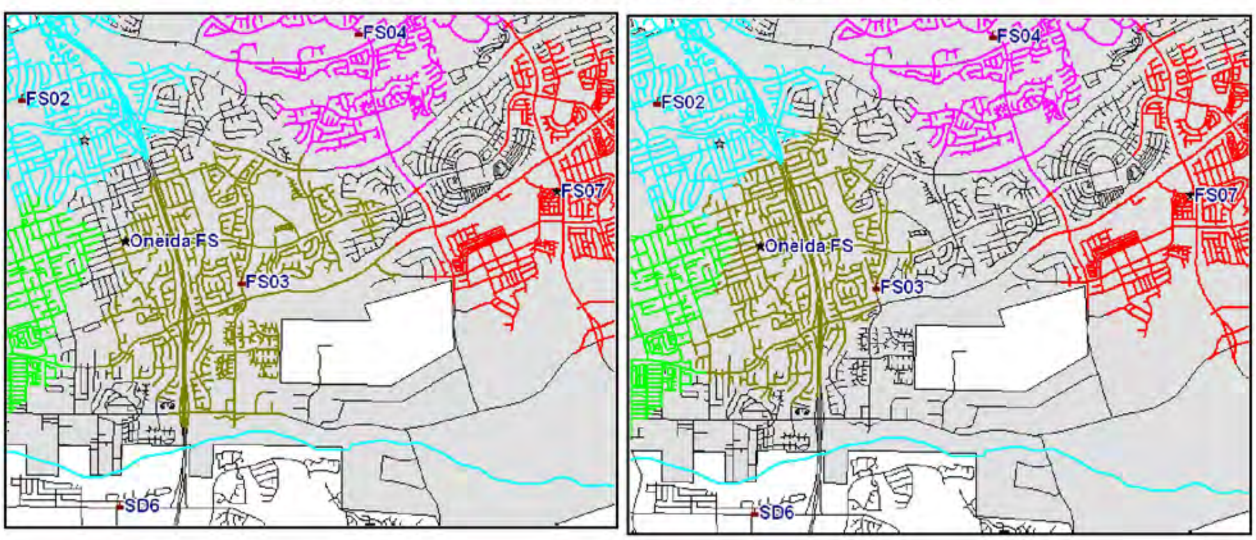
Issues

Distribution

The current delivery system has evolved over time reacting to growth, calls for services, opportunities for land, and availability of funds. This was accomplished with logic, experience, and years of understanding what it takes to deliver service to the homes and on the streets of Chula Vista.

The first issue to be addressed is the staffing of the USAR as a primary response unit. This action was necessary for several reasons. The unit had been placed in service in FS03 because it would not physically fit into the fire station on East Oneida. This required the movement of E53 to the Oneida station. The USAR does not have a pump, carry water, or carry firehose. It does not qualify under ISO standards as a primary response unit for fires. The movement of E53 to the west increased the size of an area that was underserved by ISO standards to the east of the fire station (Figure 62)

Figure 63: ISO 1.5-Mile Coverage (FS03/Oneida FS)

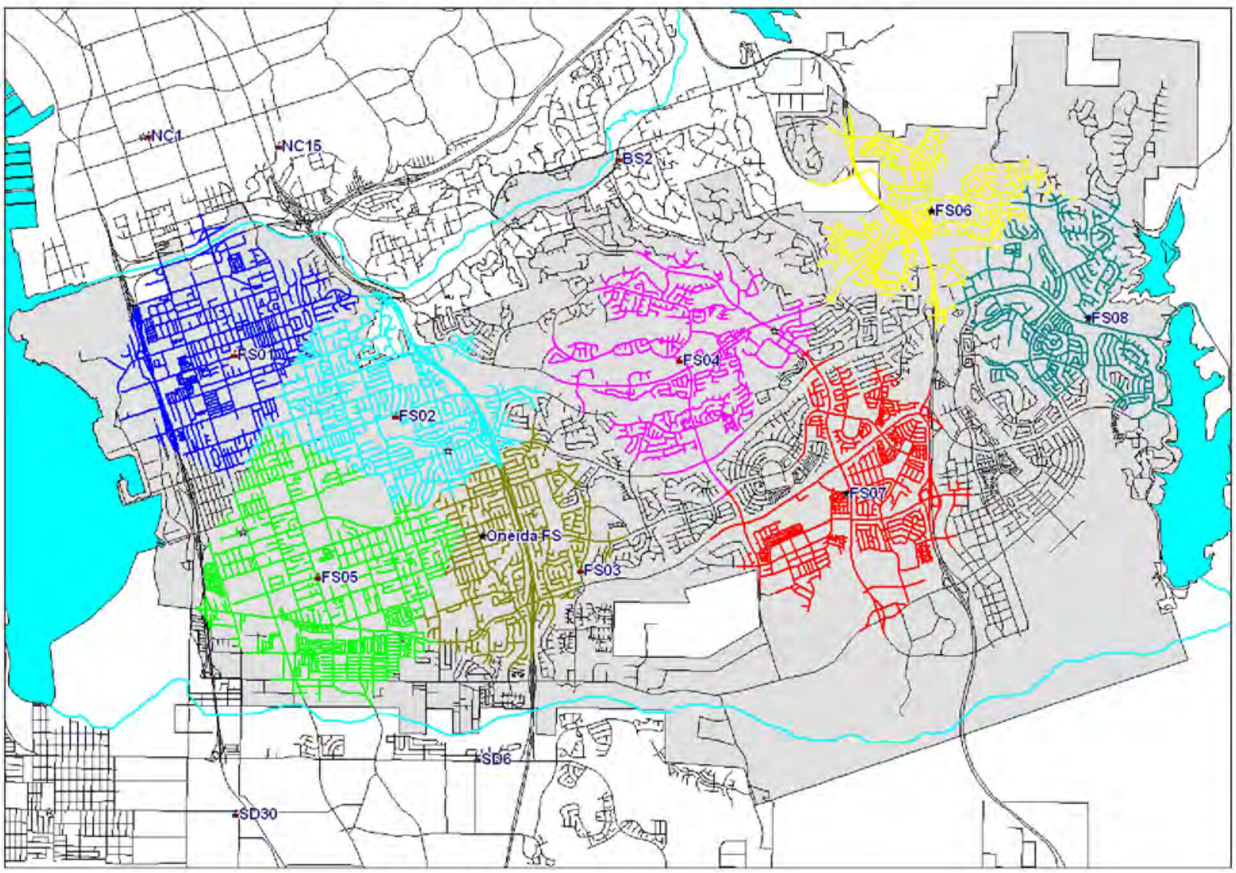


During the latest visit by ISO to the city, this deficiency was confirmed and actions will eventually need to taken to resolve the issue. The addition of the Bayfront station will likely be the trigger point for addressing this issue.

Travel Time

The primary performance measure that drives the distribution of fire stations for the CVFD is first engine company/first unit performance. Using a performance measure of having the first engine/first unit arrival within four minutes of travel time, the level of performance is at the 73rd percentile (see previous Figure 47). At five minutes, the actual performance is at the 89th percentile. Shown below in Figure 64, the west side has overlap whereas the east side has gaps (black street lines) between fire stations at 1.5 miles (distance needed for the 90th percentile four-minute travel time).

Figure 64: Service Areas 1.5 Miles - 8 Engines



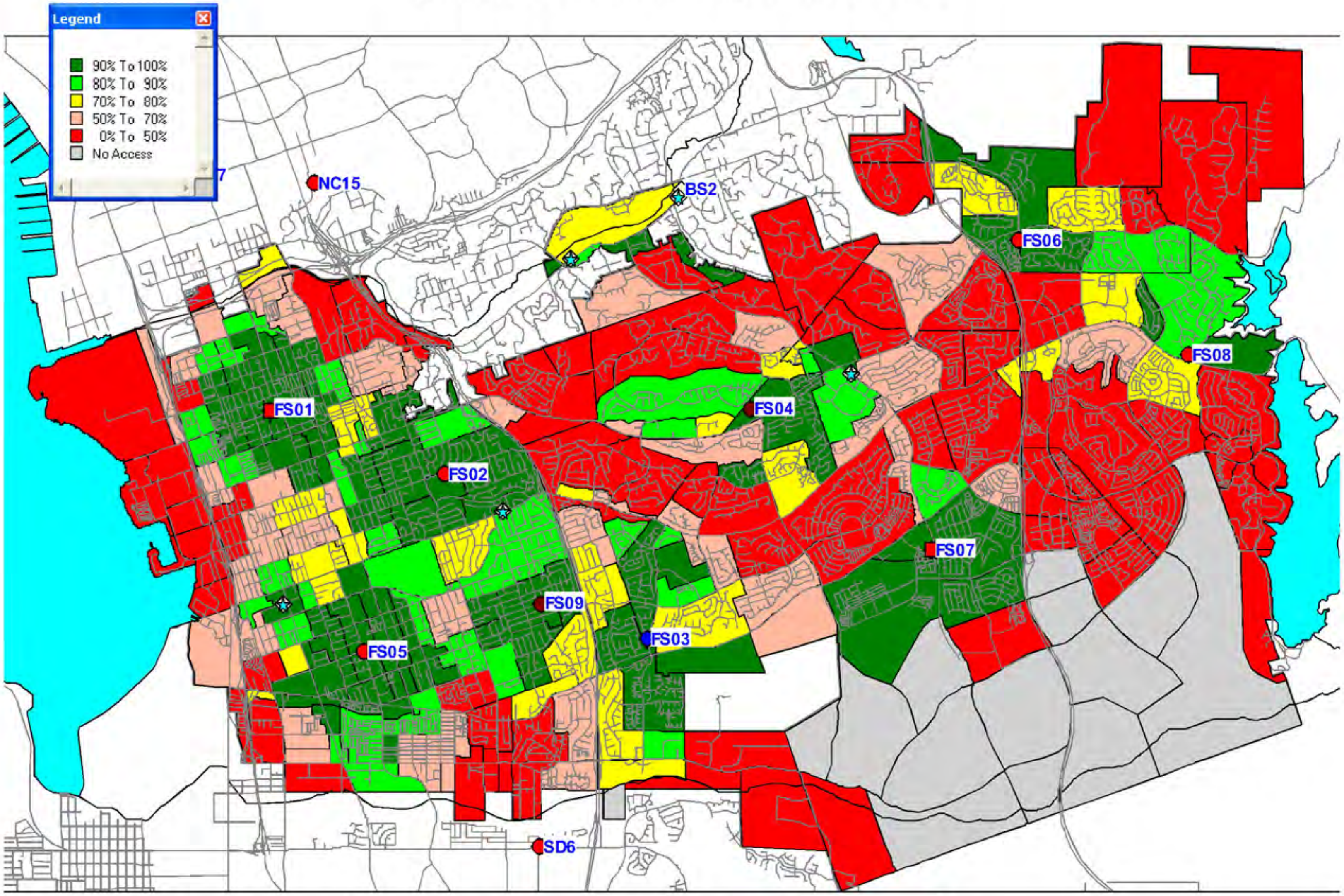
First Unit Travel (4:00) with 2009 workload and current stations is provided in the figures on the following page (ALS-Figure 65, Rescue-Figure 66, Fire-Figure 67). When the workloads projected for 2030 are applied and the new development areas added, the gray areas turn red (Figure 68) but not much else changes geographically. Performance actually falls by 10 percent (from 73 percent to 63 percent) due to the new call loading in the new development areas.

IAF (Initial Attack Force)

The second performance measure that drives distribution is IAF (also a concentration issue). The current IAF is shown in Figure 69. Actual performance was 64 percent with an average 7:41, whereas modeled performance was 84 percent with an average of 5:34. This difference here is that the modeling assumes that the units are always in quarters and the lesser number of calls for services that make every single call impact the calculation. Being out of position even a few times will affect actual performance. This current performance level is achieved with fire station spacing of approximately three to four miles between stations (east side). Increasing the performance level for IAF will require station spacing to be less than the current distance or it will be necessary to increase resources at existing stations/units. The IAF is important to the safety of the public and the firefighters as discussed in detail in the section that reviewed the critical tasking.

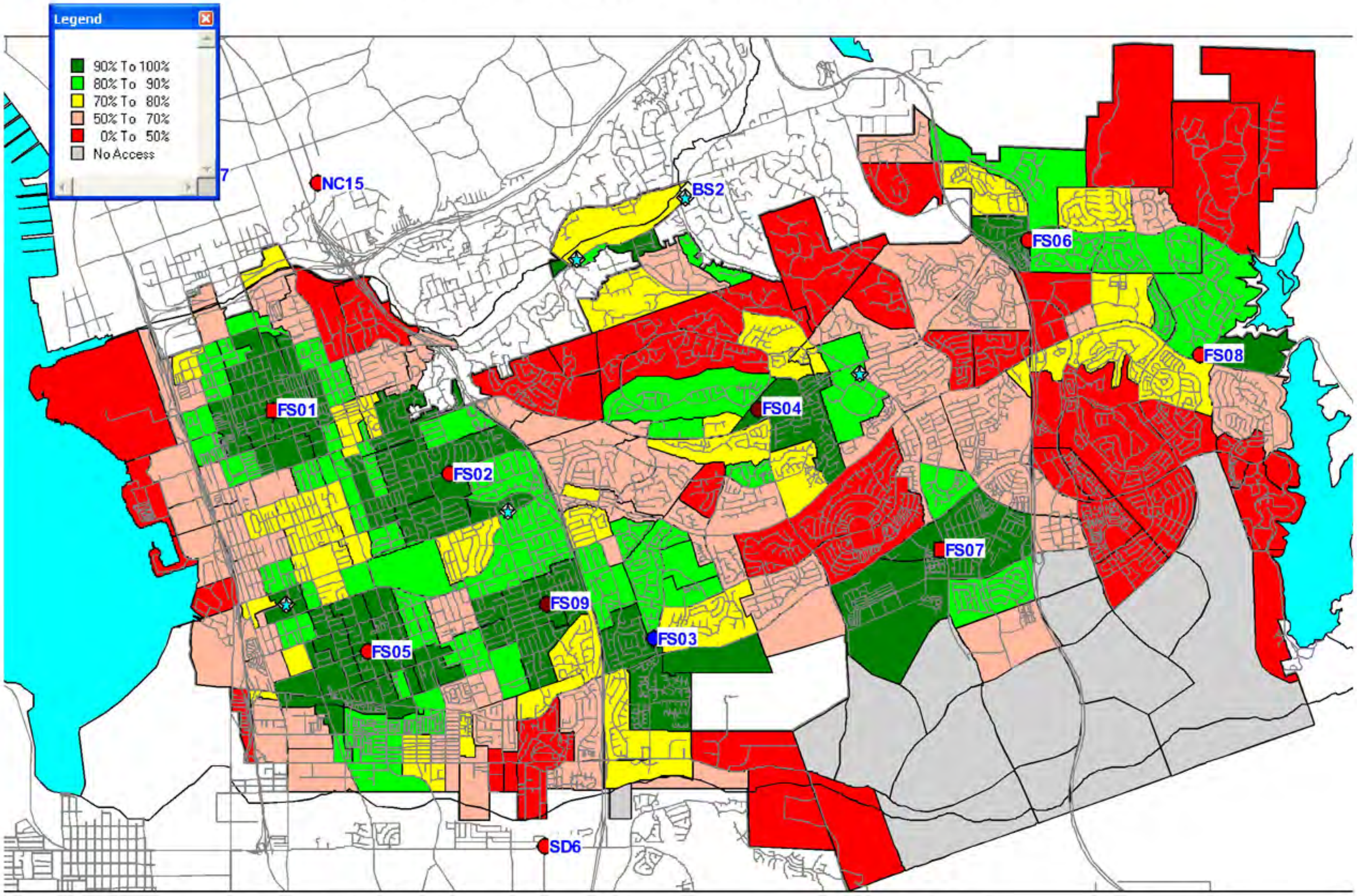
As shown in Figure 69, on the west side where fire station spacing is closer relatively good IAF is achieved; whereas on the east side compliance is not achieved, except in the areas between the fire stations (except FS07 where more than three firefighters are stationed) where the four personnel can be assembled within the performance measure (7:00). **Additional staffing at any of the six fire stations that house only three personnel will increase this performance measure**.

Figure 65: First Unit Travel - ALS - Current Stations



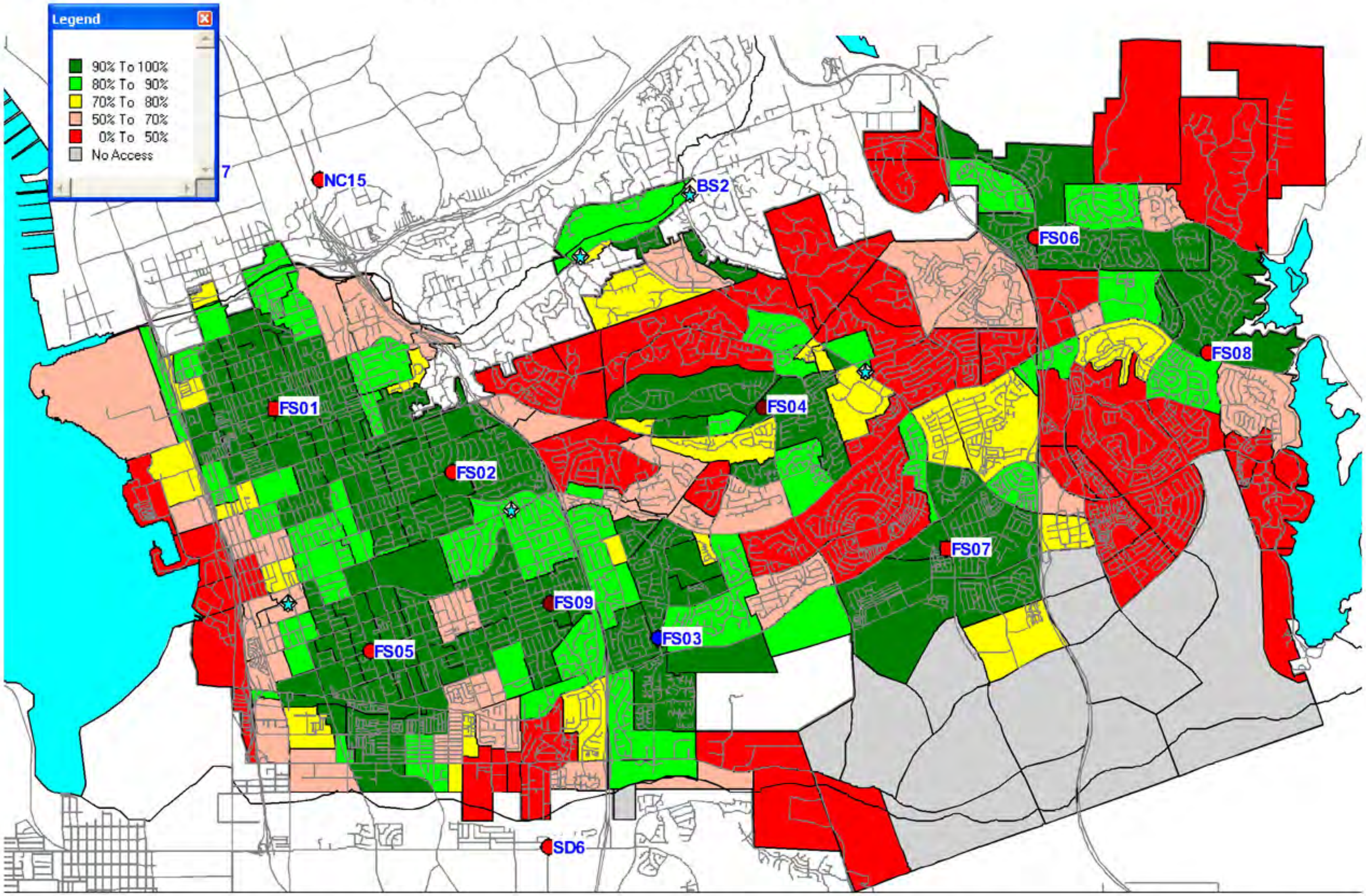
B – First Unit Travel (Enroute to Onscene) – Current Stations - ALS

Figure 66: First Unit Travel - Rescue - Current Stations



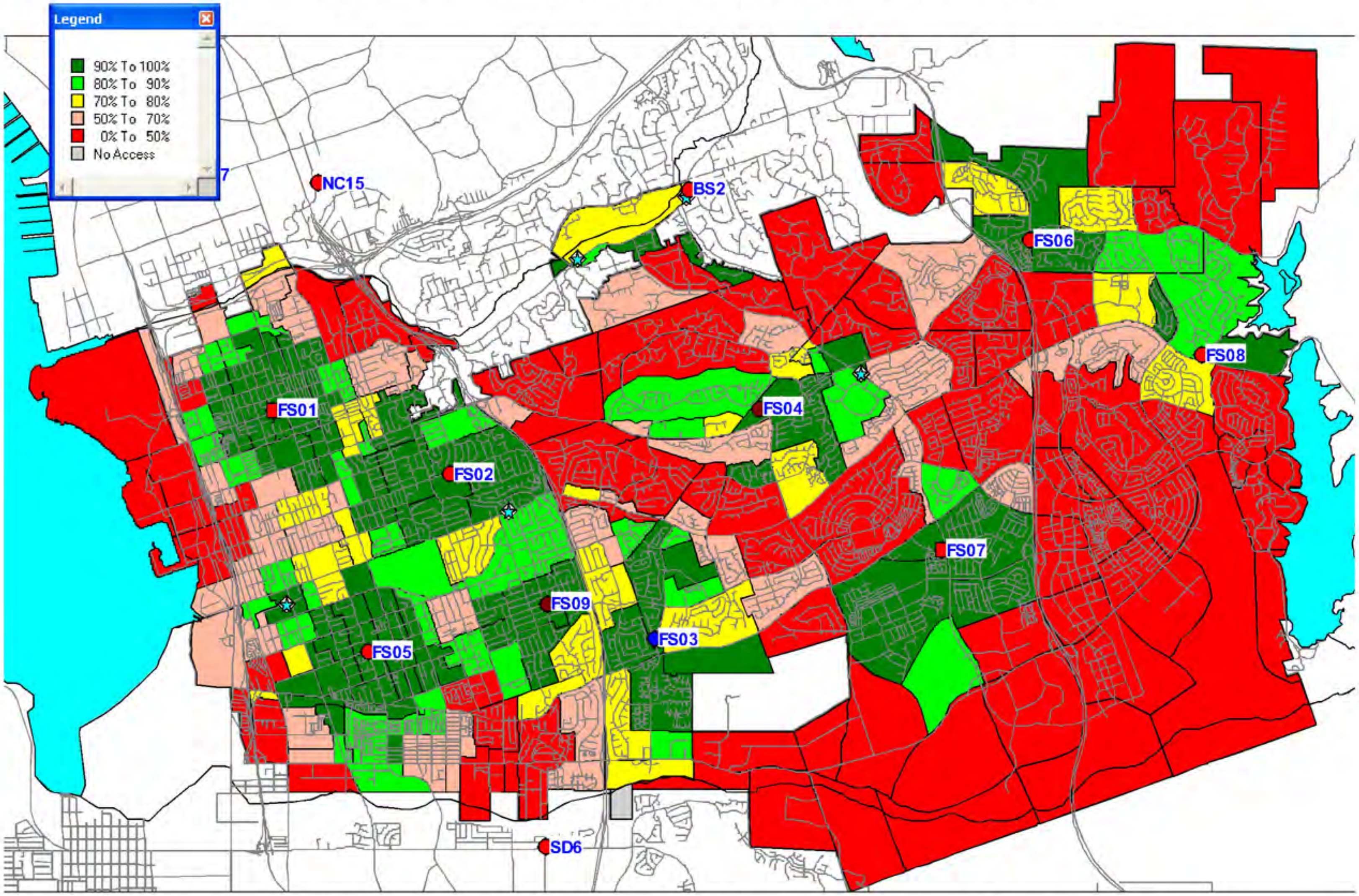
I – First Unit Travel (Enroute to Onscene) – Current Stations RESCUE

Figure 67: First Unit Travel - Fire - Current Stations



N – First Unit Travel (Enroute to Onscene) – Current Stations FIRE

Figure 68: First Unit Travel - ALS – Build-out 2030 - Current Stations



B – First Unit Travel (Enroute to Onscene) – Buildout 2030 - Current Stations ALS

Figure 69: Initial Attack Force - Current Stations

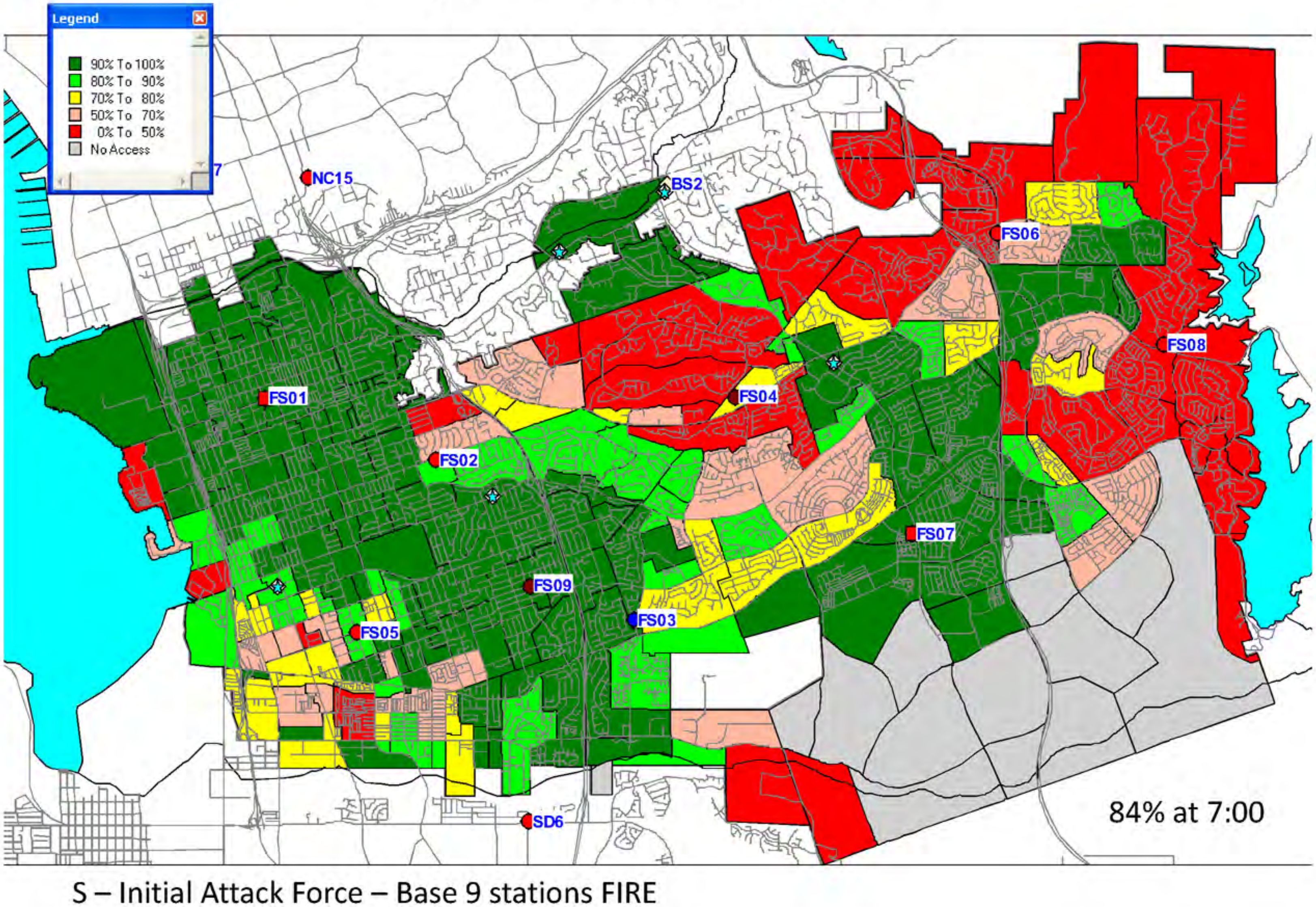
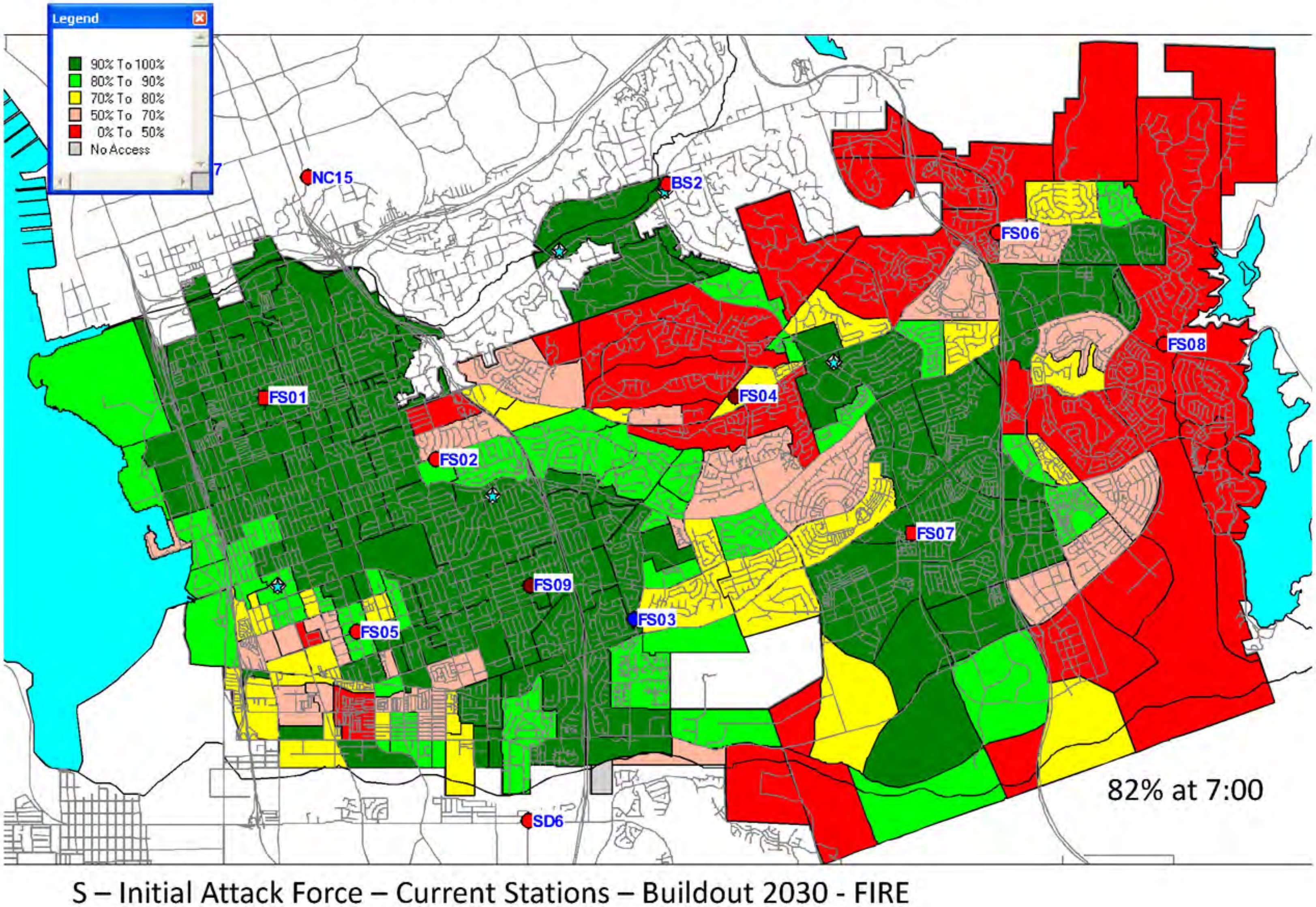


Figure 70: Initial Attack Force - Current Stations - Buildout 2030



Future Development

The City will expand considerably over the next 20 years. The remaining villages will increase the population by nearly 54,000 and generate an estimated 3,426 calls for service. In addition, the university area will add another two calls per day (720 calls) when fully developed. However, the call load alone is not the issue. The development is spread over a large area and with travel time of four minutes set as the standard; these villages will create the need for additional fire stations. Projects in the balance of the city will generate an increase in population of about 27,000 and an increase in call loading by approximately 1,734 calls for service. With all currently planned development combined, the system will see an increase in demand of 5,881 calls or nearly a third again what is currently being serviced.

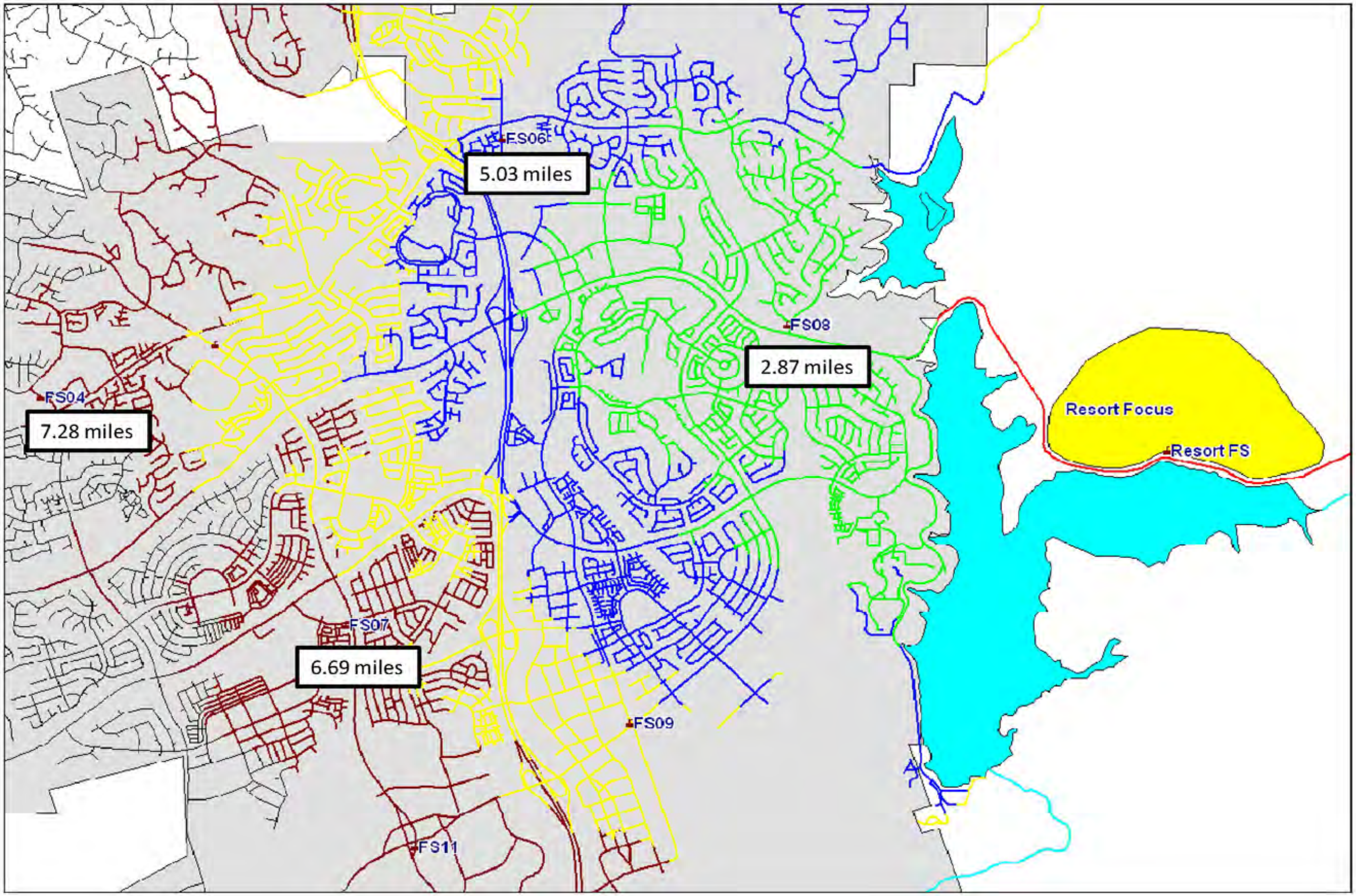
Beyond the development planned in current General Plan, the JPB Proposal would increase the core areas around Villages 3, 8 east, and 10 by an additional 20,000 population, resulting in approximately 1,299 new calls for service. This call loading is in addition to that of the General Plan increase (3,426 for Otay Ranch Villages) bringing the overall system demand up to 7,180 new calls for service. This is half again the current workload.

Beyond the existing city limits, the east unincorporated areas will bring more challenges to the fire/EMS services when incorporated into the city. Three areas have been identified:

- Resort Focus Area
- Proctor Valley District
- San Ysidro Mountain District

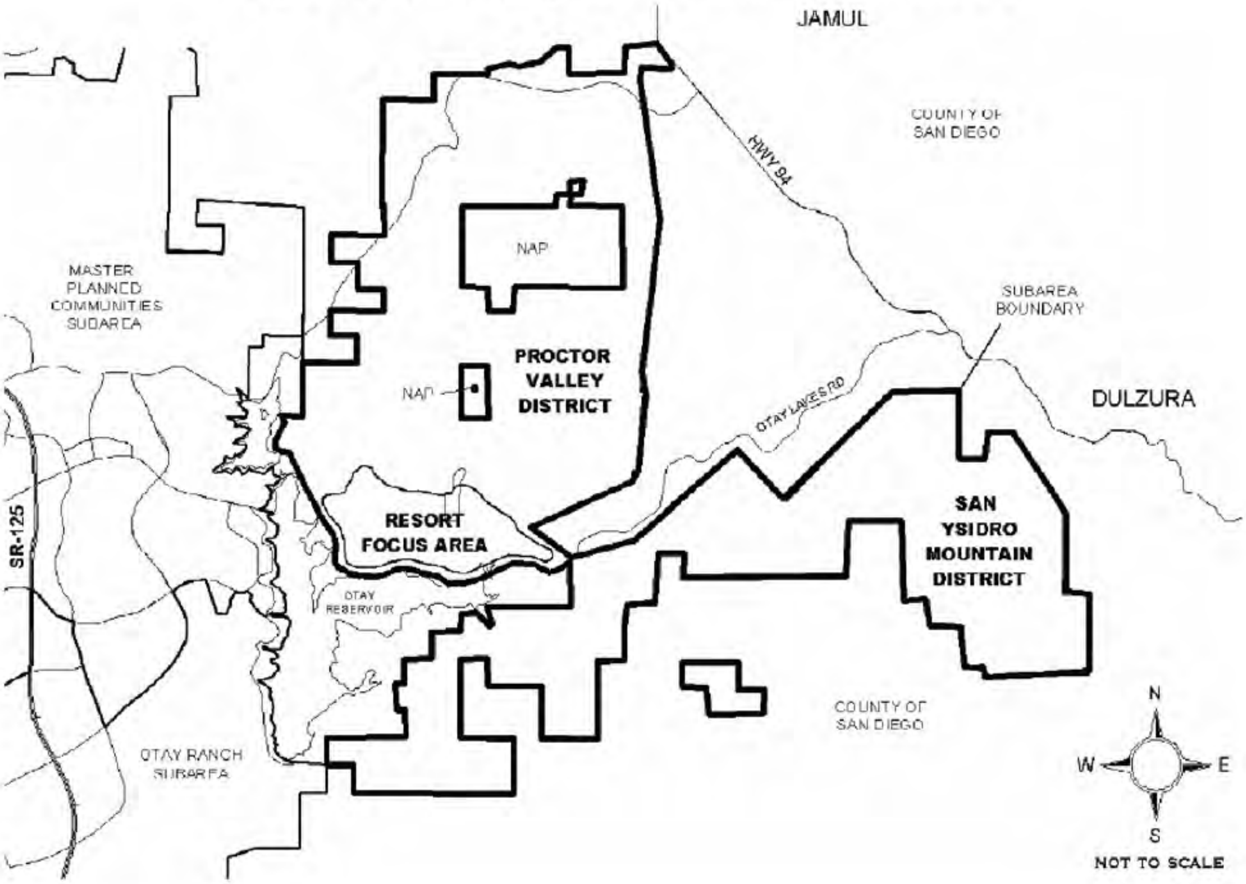
The center of the Resort Focus Area is approximately 2.9 miles from FS08. This distance is too great to provide adequate coverage from FS08. This area will require a new fire station to provide first due response to the resort within both the Fire Department Strategic Plan performance measures and the GMOC performance measures. Distances to the four closest existing stations are shown in Figure 71. The Resort Focus Area will have a single arterial through which all fire/EMS assets will have to travel for many years. This area will have concentration issues as well with the distances to the nearest truck, battalion chief, and additional engines.

Figure 71: Travel Distances to Resort Focus Area



The Proctor Valley District and San Ysidro Mountain District shown below are expansive areas with difficult topography. They will likely be developed as rural areas but the configurations make servicing them difficult. In addition to distribution issues, they will have concentration issues as well. The city may need to adopt new performance measures for these areas.

Figure 72: Proctor Valley and San Ysidro Mountain Districts



Concentration

Concentration issues are related to call loading and the distance between assets. These issues are measured by the assemblage of resources to adequately service the nature and number of calls for service that are produced. Concentration issues are highly impacted by the type of development that occurs. First of these is population. Citizens are using the fire/EMS services more than they used to. The call rate per 1,000 population has increased steadily over the years. Even if population were to remain constant, the number of calls for service would increase.

The second issue that compounds the problem is the aging of America. According to SANDAG and the U.S. Census Bureau, Chula Vista will see a significant growth in the number of citizens who are over the age of 64. This population will essentially double. This segment of the population uses EMS services at a rate four times the average. This factor will increase call loading beyond the additional 7,180 additional calls that are driven by development.

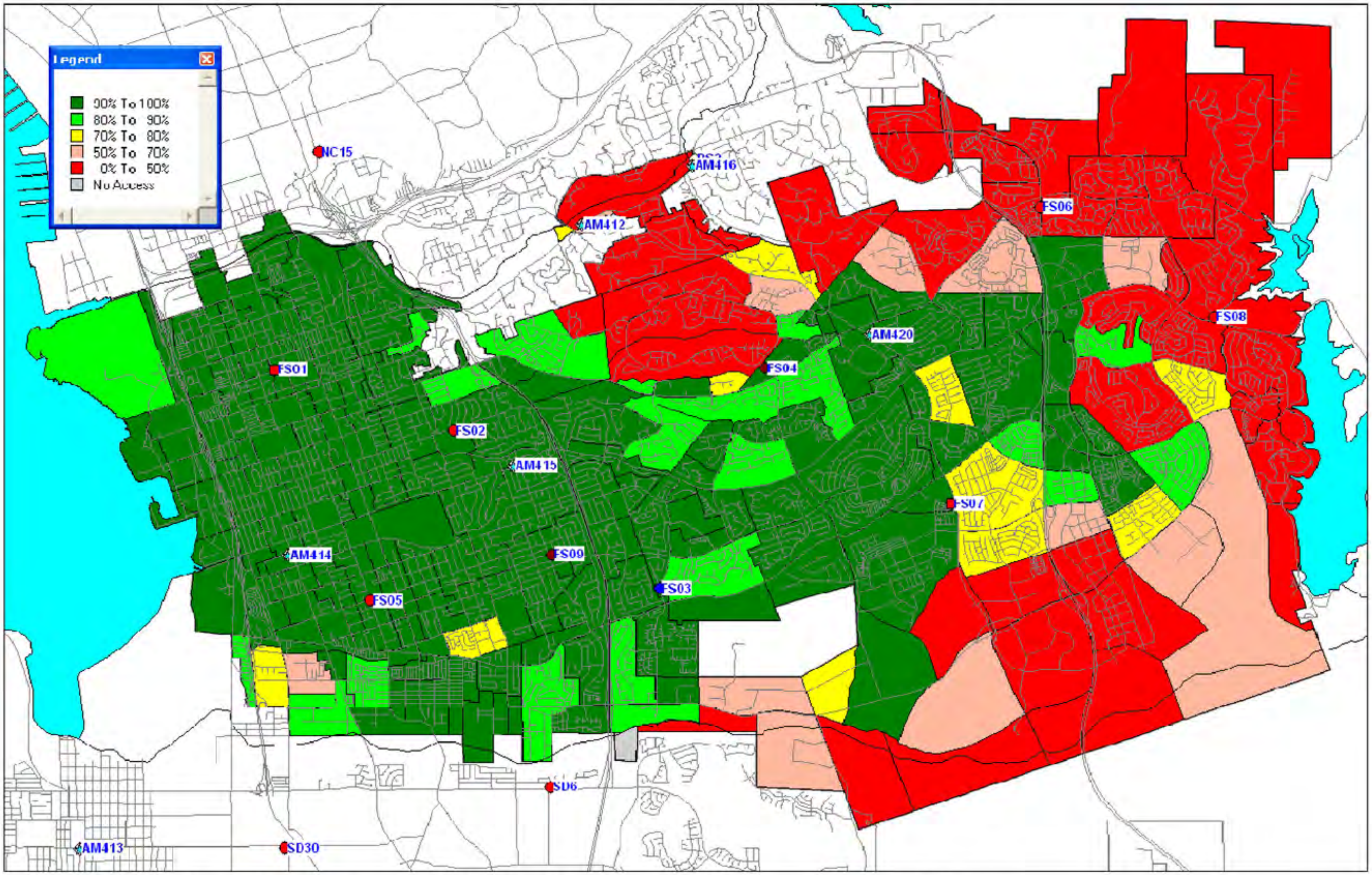
EFF (Effective Fire Force)

The primary concentration performance measure is the goal of having the effective fire force arrive within 10.5 minutes of being dispatched (or eight minutes travel time) to a level of performance at the 90th percentile or greater. Engine company performance also drives this factor, but the distribution of ladder trucks and chief officers is important to the achievement of the EFF as well. The current performance for the EFF in 2009 was 82 percent at 8:00 with an average of 6:15 travel time. The model produced a performance of 87 percent (6:19 average) with nine fire stations. When the 2030 workloads are applied, the performance for EFF drops to 78 percent and the average increases to 6:41. The build-out performance is shown graphically in Figure 73.

As with IAF, the west side is reasonably well protected due the closer spacing of fire stations. On the east side, the same basic pattern emerges. Areas at the center of the protection area can assemble the concentration of assets needed to meet the performance measure while those on the outer areas do not.

New fire stations needed to meet basic distribution will have a positive effect on the EFF as well.

Figure 73: EFF – Build-out 2030 - 9 Stations



U – Effective Fire Force (E,14 FF)– Buildout 2030 - 9 stations FIRE

Specialty Units

The need and placement of specialty units is always a difficult one. These are not like the engine companies that provide the basic delivery platform for the system. Truck companies and battalion chiefs have different roles and responsibilities. They carry specialized tools, equipment, and in some cases training that provides very specific services to calls of a special nature. For example, the truck companies not only bring a full complement of ground ladders and an aerial device, but they also bring specialized rescue equipment (Jaws of Life, specialized saws, and lifting equipment and ropes) and the manpower and specific orientation to get the job done. Calls for truck companies include structure fires, auto accident, technical rescues, any call where it is necessary to gain access through or into something or somewhere and the tools necessary to save, protect, or salvage as much property as possible during the emergency. The current system has only two of these resources. This is not enough to support the level of development that will be present at build-out.

Battalion chiefs not only provide supervision in nonemergency environments but also manage nearly all emergencies that require more than two resources. They bring equipment, knowledge, and the responsibility to focus on the emergency as well as the bigger picture on calls. This may include environmental issues, preventing catastrophic events, managing scare resources and making decisions on risk/benefit tactic and strategies. Having adequate chief officer coverage allows company officers to focus on their responsibilities and crew. The current system has two of these resources. Additional battalion chiefs may be necessary depending on the final number of fire stations and the distance that needs to be covered in a timely manner.

Sometimes, the truck company simply does not have the right specialized equipment or training for the extreme emergencies. Urban Search and Rescue units (USAR) are designed to provide the highest level of rescue equipment, staffing, and training available within the fire service. Chula Vista has the advantage of having such a unit. The USAR does not respond to calls on a daily basis that need this level of intervention. This tool is necessary to have available but does not have to be available in the same timeframes of that required of an engine company. Chula Vista needs to retain this capability in a manner that allows the asset to respond when needed in a timeframe that is acceptable to the risk.

Wildland interface issues exist within the City of Chula Vista and will become more pronounced as the city grows into the areas east of the lake. The city currently cross staffs a Type III wildland engine. It will be necessary to either increase the number of Type III engines or utilize WUI (Wildland Urban Interface) engines at some of the stations nearest to the interface. The existing Type I (normal fire engine) engines will not be able to leave the paved streets and thus will have to limit wildland firefighting to progressive hoselays from the paved streets and/or structure protection when the fire arrives at the structures. It should be noted that as the city annexes lands into the city limits, they will no longer be SRAs (State Responsibility Areas) and the resources that are currently protecting them as provided by CAL FIRE, BLM, and other wildland agencies will not be provided without cost to the city. In a large fire, the mutual threat of the fire may be enough to have the state and federal assets be provided without cost, but the city has a responsibility to keep smaller fires in check so that they do not reach this level or it will ultimately bear the financial responsibility of the fire.

Water is a critical issue in wildland firefighting. Water tenders are large water tankers that are used as "water points" or to resupply wildland engines during a wildland fire. This asset is extremely critical to the early success of a wildland firefighting operation. More wildland fires have grown to be large fires due to lack of water than most any other factor. Once a progressive hoselay is started, if it cannot be supported with continuous water, it will be overrun and be unsuccessful in stopping the forward progress of the fire. Like the USAR, this asset is not used on a daily basis but presents all the same reasons for having the ability to deploy the resource in a timely manner when needed.

Reliability

In general, reliability is the ability of a system to perform and maintain its functions in routine circumstances, as well as hostile or unexpected circumstances. For Chula Vista, this means the ability to meet the performance measures for 90 percent of the calls for service that occur. FS01 has a very high call load but the station has two units and handles it well. FS05 has a current call load that is nearly exceeding its ability to provide service. This, coupled with a large coverage area, makes its reliability questionable. Some action will need to be taken to reduce the workload or increase the resources at FS05. The only other area within the city, current or proposed, that will have reliability issues is the EUC/Villages 8, 9, and 10 areas. This area will have a significant level of call loading. The university and JPB proposals will only increase this impact on the system reliability in this area. Fire stations in this area will have to be spaced closer together and built to house more than one resources in order to address this potential problem in the future.

Analysis

Issues have been raised with travel time, IAF, and EFF for the current system and the development areas. An analysis of potential fire station sites was undertaken to see where new stations might be considered that will have the greatest benefit to the existing delivery system and the new development areas.

Fire Station Sites

Current and possible fire station sites within the existing and proposed city are listed below so reference can be made to them by site number in order to simplify the results of the analysis:

Figure 74: Current and Potential Fire Station Locations

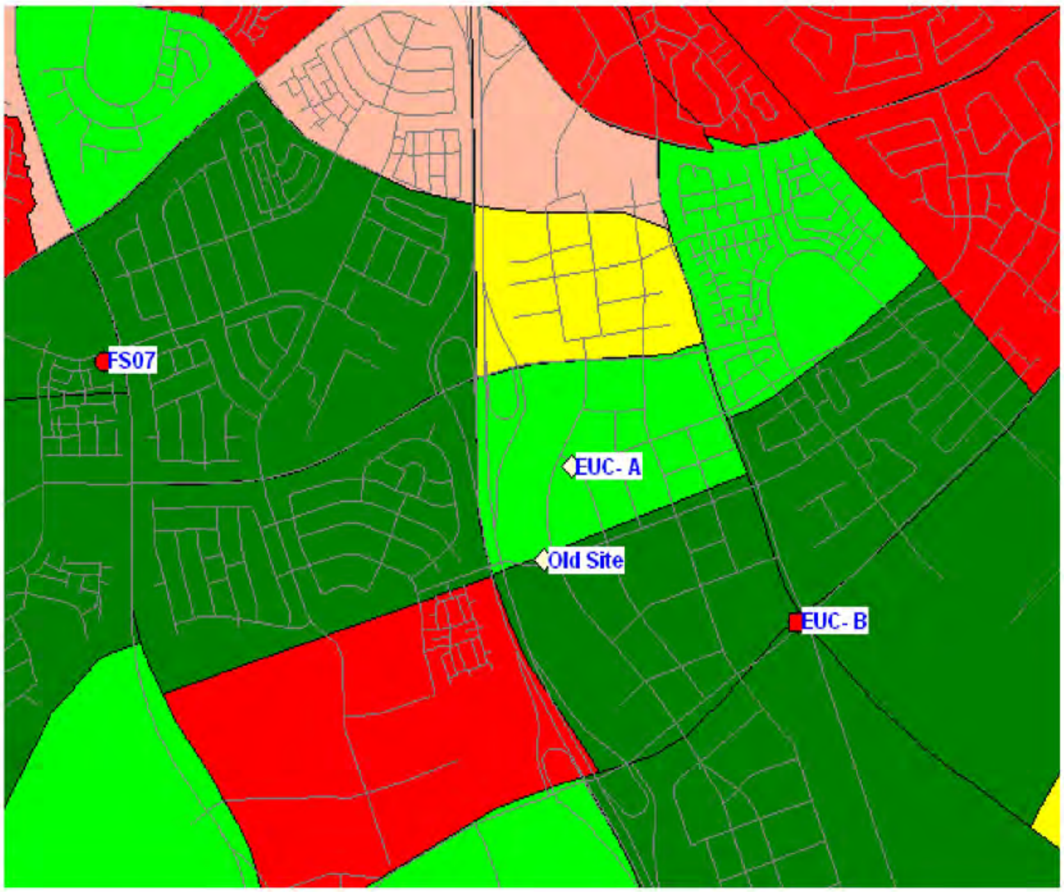
Site	Street 1	Street 2
1	Current FS1	--------------------
2	Current FS2	--------------------
3	Current FS3	--------------------
4	Current FS4	--------------------
5	Current FS5	--------------------
5A	Orange Ave	4th Avenue
6	Current FS6	--------------------
7	Current FS7	--------------------
8	Current FS8	--------------------
9	Oneida Street	Monterey Avenue
EUC	Eastlake	Hunt Parkway
Bayfront	Bay Blvd	J Street
Village 8	La Media Rd	S of Rock Mountain Rd
Resorts	Otay Lakes Road	Resort Focus

Many solutions have been considered. Some have been discarded as unusable; while others will need more study. The solutions provided here are those that appear to provide the most improvement at the least cost while still providing for movement towards the stated goals of the Chula Vista Fire Department.

Eastern Urban Core (EUC)

The Eastern Urban Core, University, and Villages 8, 9, and 10 will be the most densely developed area within the city. This general area will generate enough calls for service to employ more than a single resource by itself. The area has been slated for a new station from the initial concepts of the Otay Ranch. The station should be designed for multiple units (three or more). The location of the station has changed as the infrastructure and development plans have become more concrete. In this study, three sites have been modeled. These are shown below in Figure 75.

Figure 75: EUC Fire Station Locations



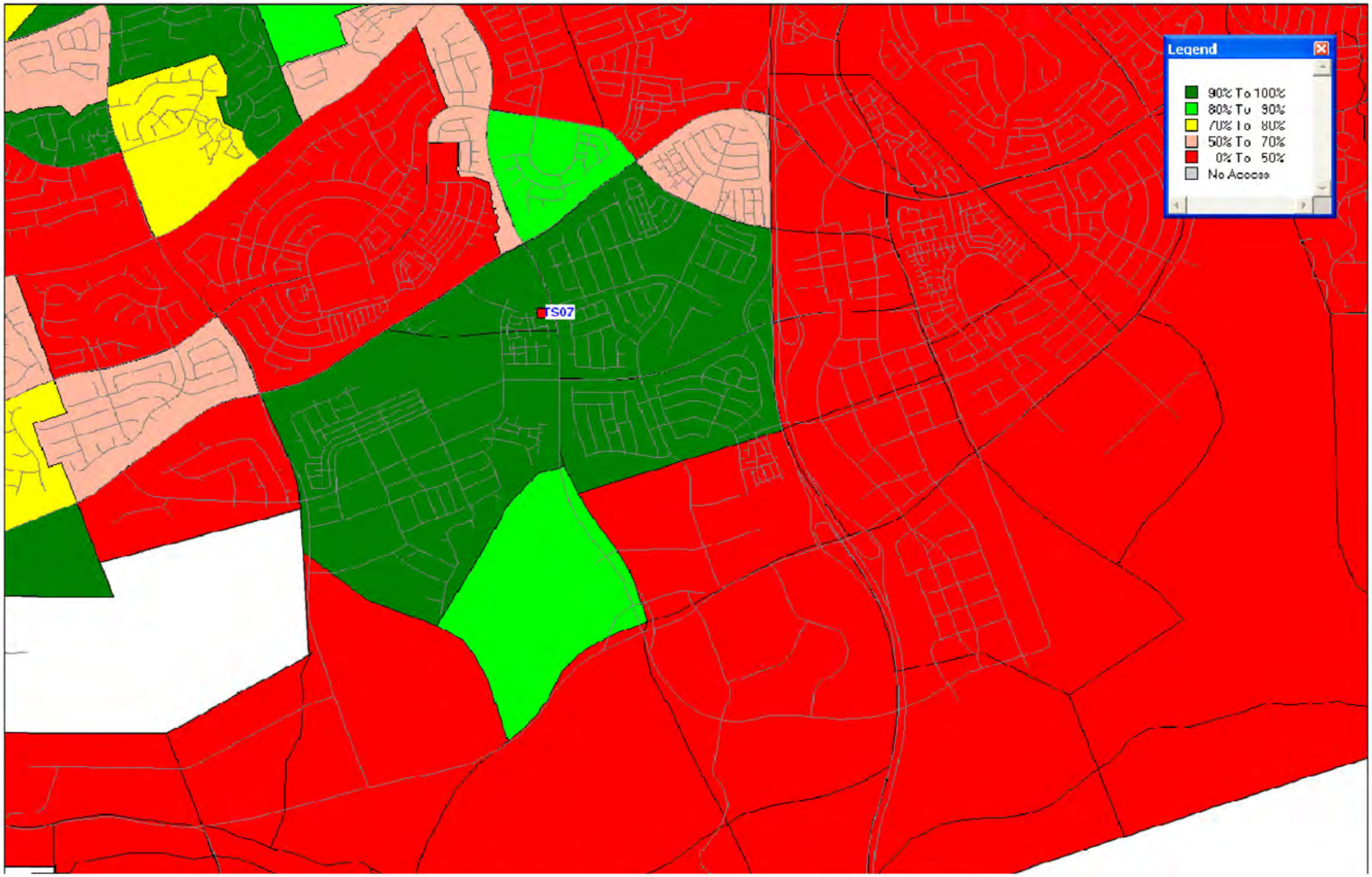
These include the original site (Old Site in graphic), Site A as currently planned, and Site B at Eastlake and Hunt Parkway. The old site is problematic in several ways and modeling was completed in a previous study that showed the Site A was superior. Site B has been modeled to increase the effectiveness of the fire station by increasing the distance between FS07 and the new EUC location. The Site B places the fire station at "center mass" of the high density areas with the Otay Ranch development. This action helps to keep the number of stations to the minimum needed to provide the services needed at the performance measures that Chula Vista has established.

This site has been evaluated on three performance measures. First is travel time for the first unit. Figure 76 shows the travel time performance with the 2030 workloads prior to any new fire stations being added. Figure 77 shows the Travel Time with Site A and Figure 78 shows the performance for Site B. Site B shows better overall performance. First unit travel increases from 63 percent (2030 workloads without new stations) to 73 percent at Site B. This is the biggest increase that will be shown by any fire station due to the high call volume. In these scenarios, the truck and battalion chief from FS07 were also relocated to the EUC station to help with the call volume. System-wide performance is shown in Figure 79.

The second performance measure is IAF. IAF overall was affected by only one percent with the 2030 workloads because of the proximity of FS07 to the new call loading. However, the EUC station increases IAF by 5 percent to 87 percent overall. System-wide performance for IAF is shown in Figure 80.

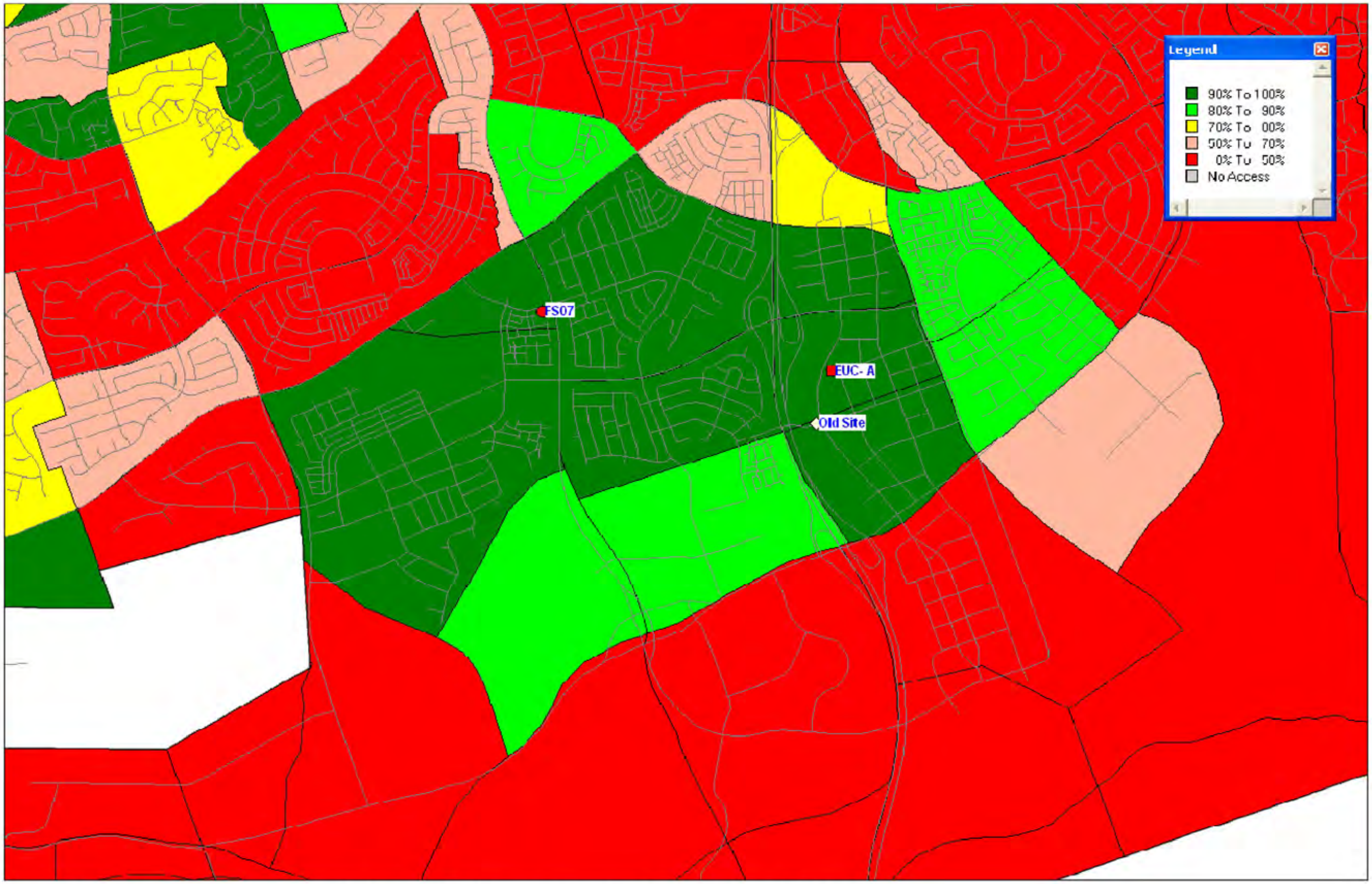
The final performance measure is EFF (Effective Fire Force). System-wide EFF dropped from 87 percent to 78 percent with the 2030 workloads. The net effect of moving the truck and battalion chief to the EUC station to help with call loading is that the EFF is reduced as some cover is traded from the area around FS04 for areas around EUC. The EFF increases to 84 percent but this is still lower than leaving the truck at FS07. The new coverage areas are shown in Figure 81 for EFF. When call loading is still low, the truck and battalion chief should likely remain at FS07 but when call loading requires additional resources, moving the truck to the EUC station and staffing a new truck at FS04 (discussed later in this section) makes more sense from and overall performance standpoint.

Figure 76: Travel Time Performance Prior to EUC Station



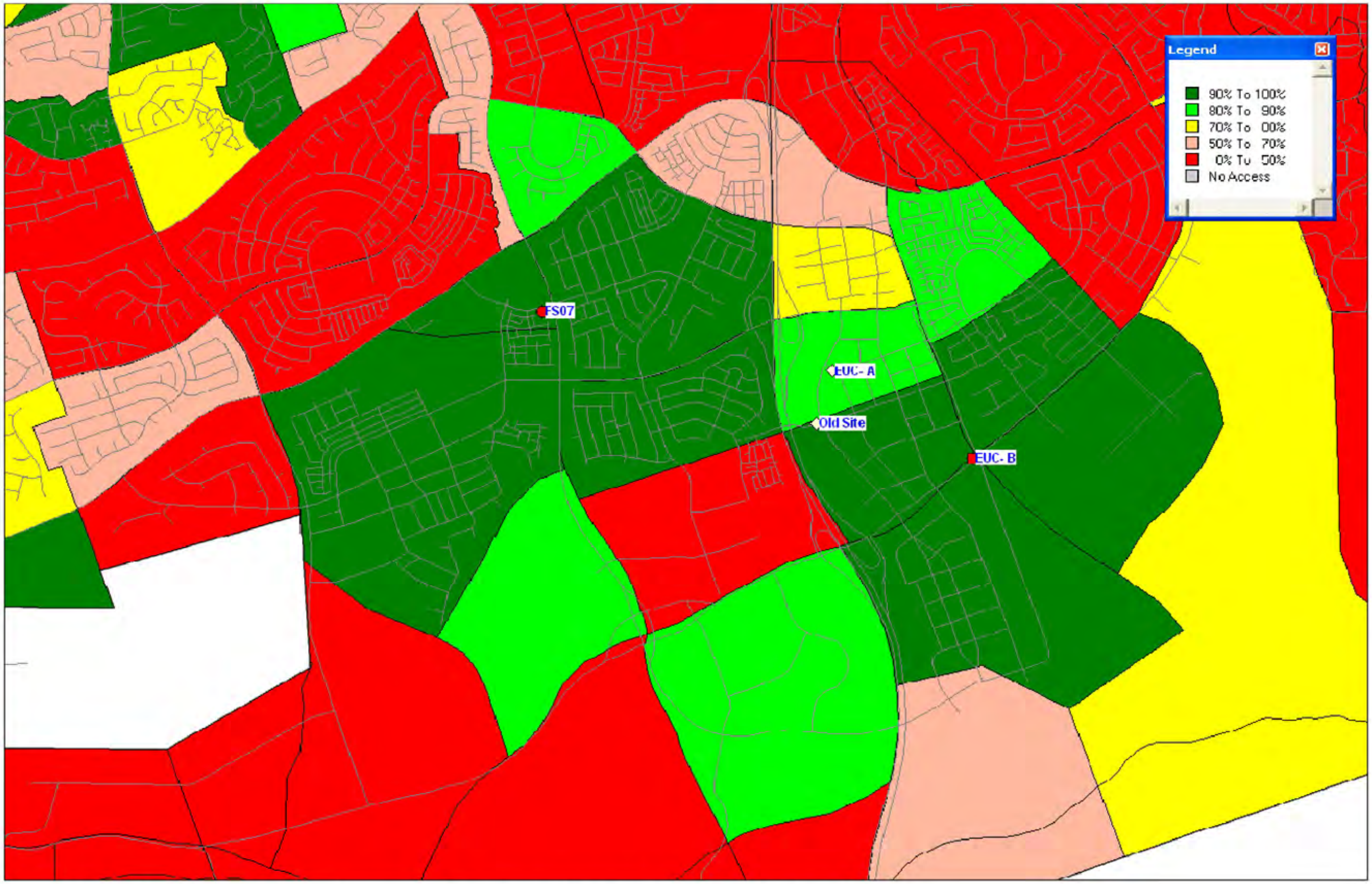
Performance Prior to EUC Fire Station – Travel Time (4:00)

Figure 77: EUC Site A - Travel Time First Unit



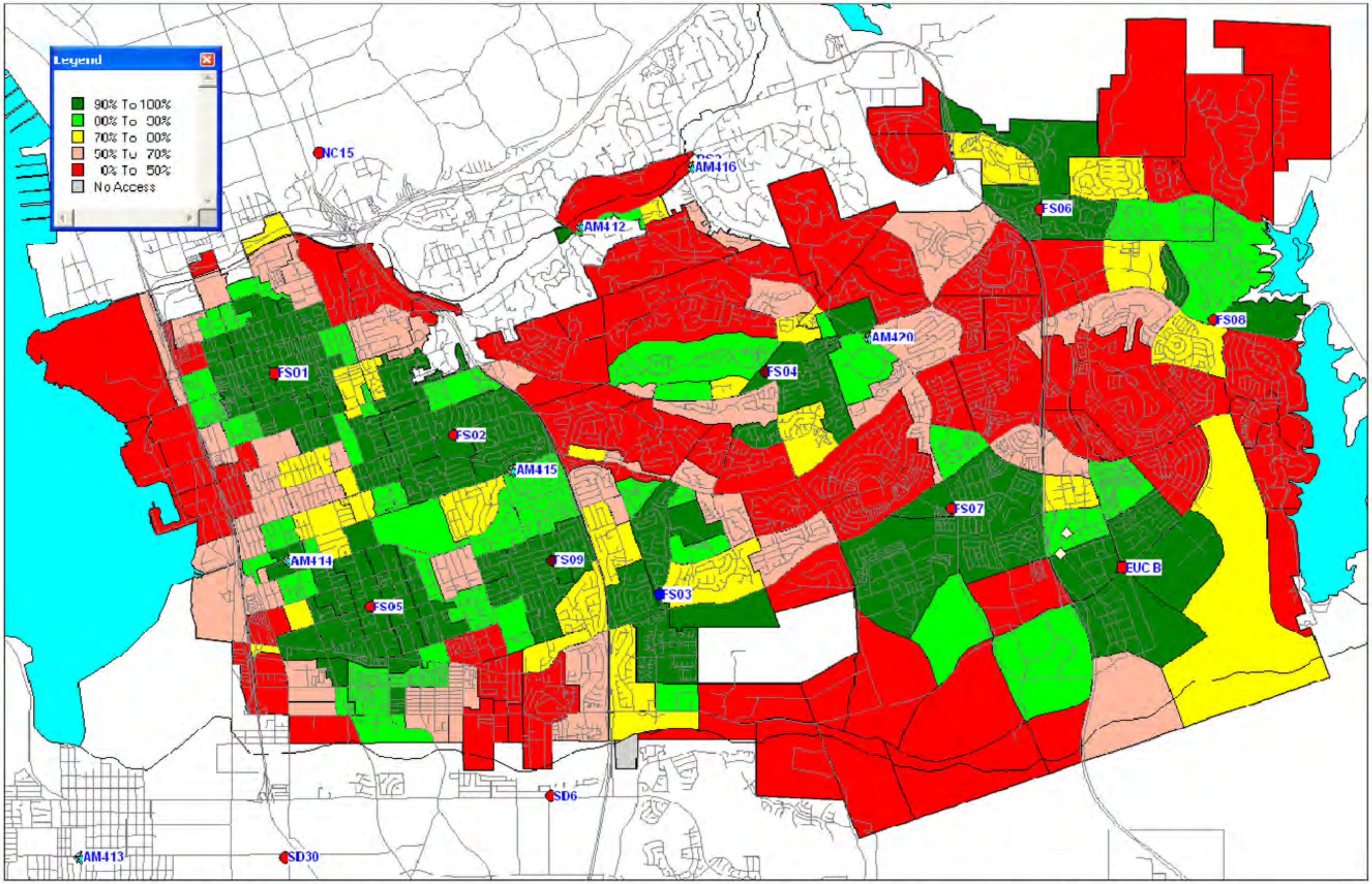
EUC Station – Travel Time (4:00) at site in NW EUC (EUC-A)

Figure 78: EUC Site B - Travel Time First Unit



EUC Station – Travel Time (4:00) at site in SE EUC (EUC-B)

Figure 79: EUC Station Added - First Unit Travel – System-wide



B – First Unit Travel (Enroute to Onscene) – Buildout 2030 – Current with EUC - ALS

Figure 80: EUC - Initial Attack Force (EUC Station Added and T7 relocated to EUC)

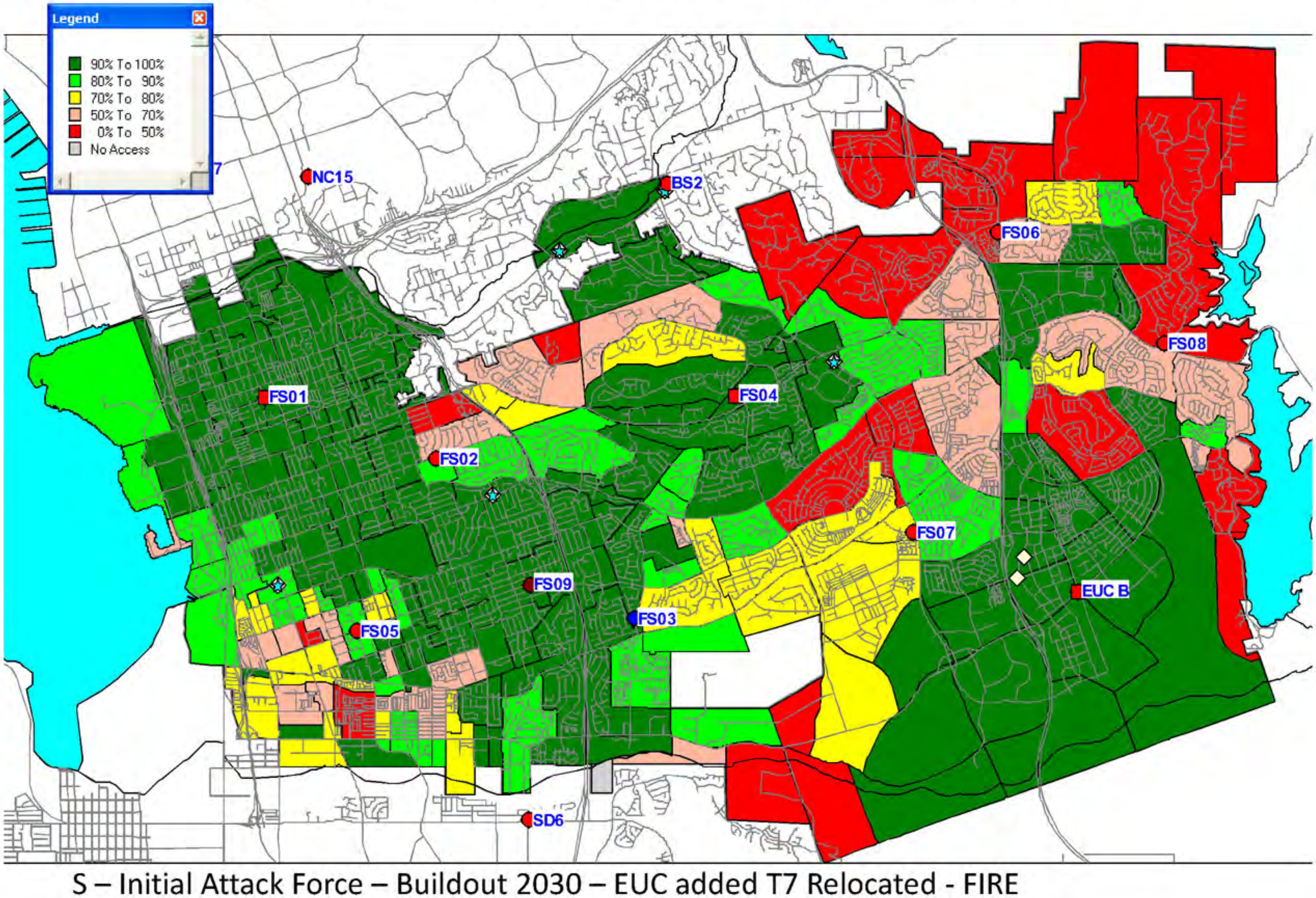
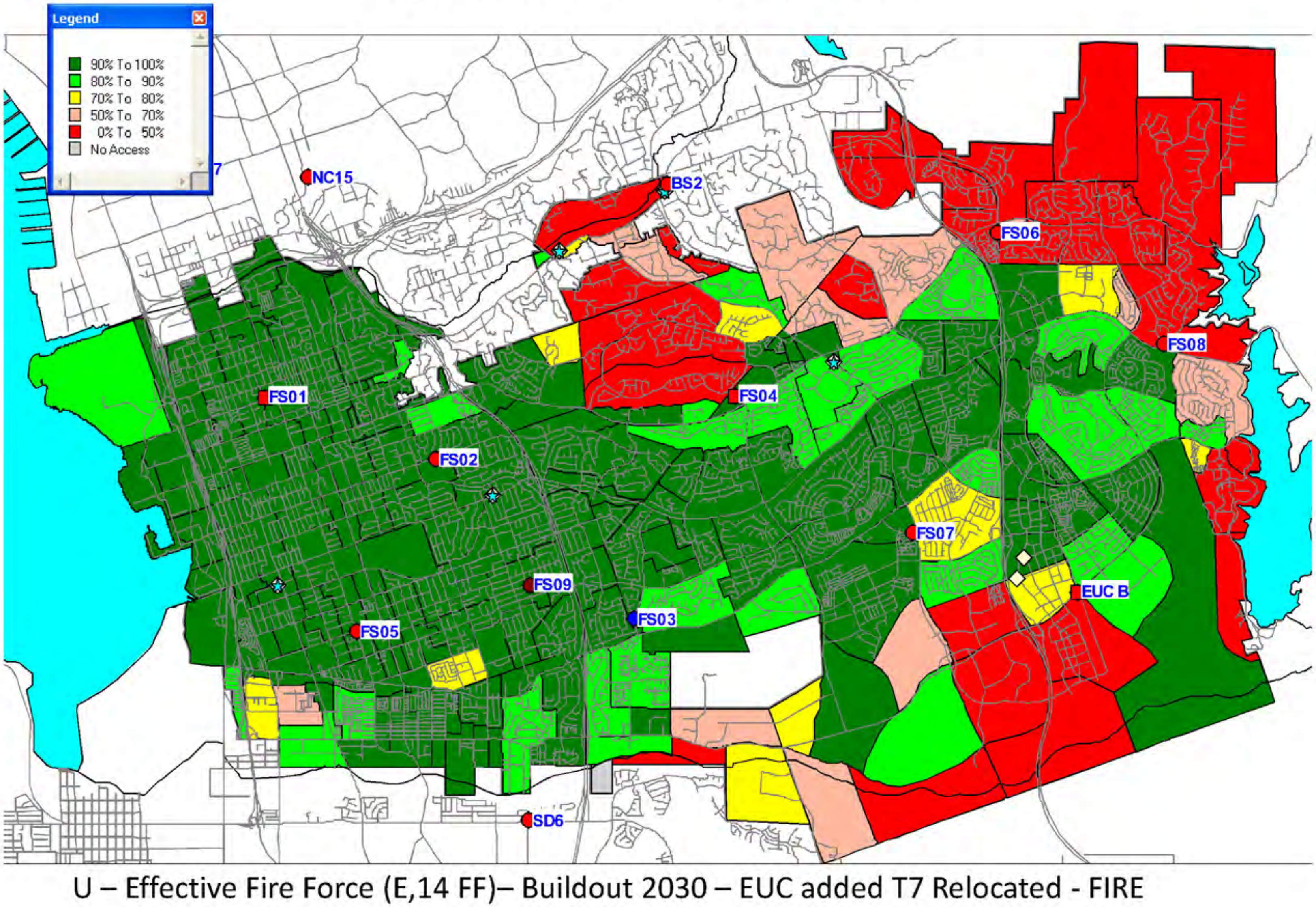


Figure 81: EUC Station Added - Effective Fire Force



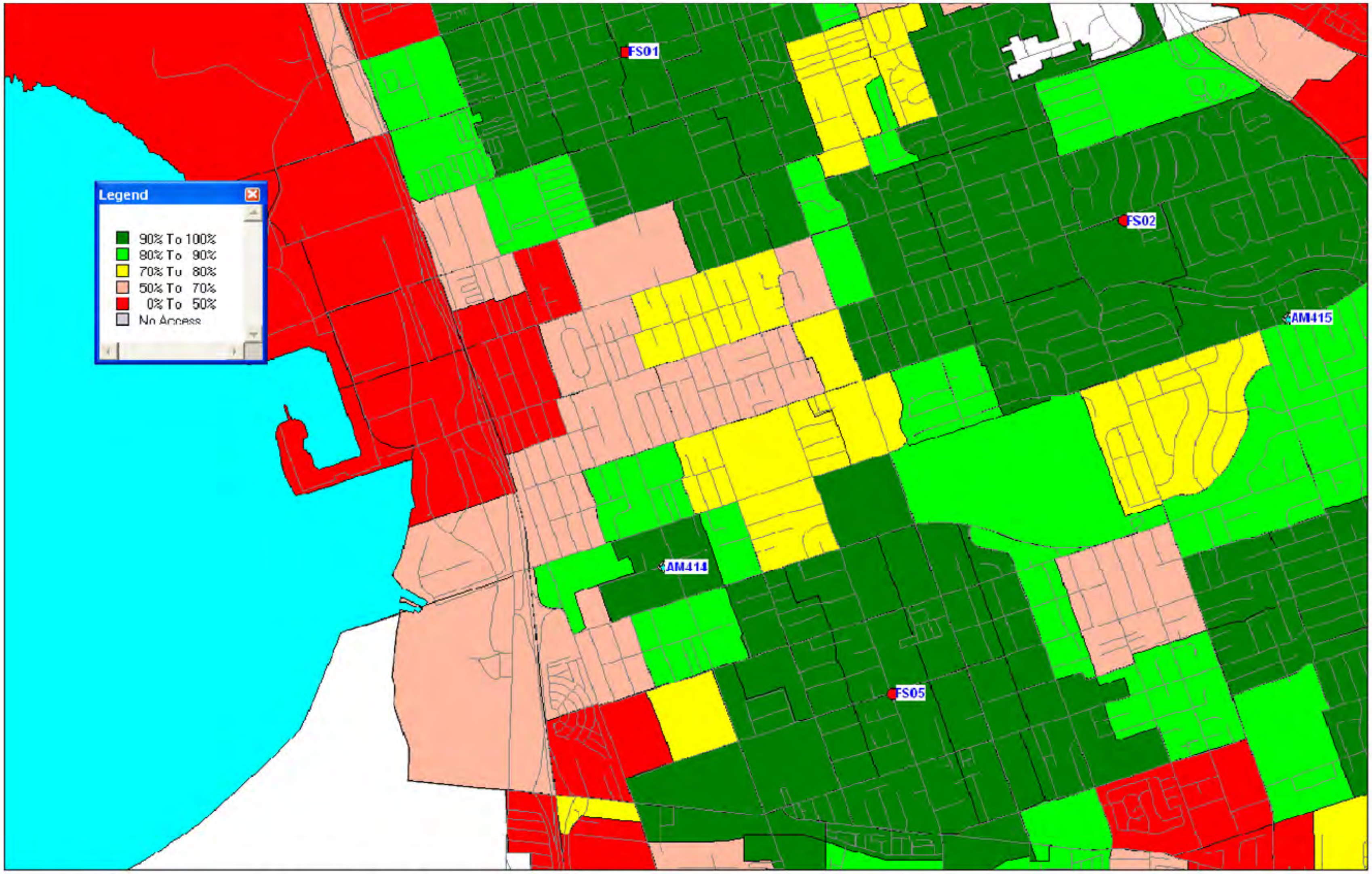
Bayfront (J and Bay)

The Bayfront will intensify under the current development plans. A fire station has been planned for the area around J and Bay for several years. This station will be the primary unit for the Bayfront/Harbor area. It should be built to accommodate at least two units (engine and truck) for the potential of high-rise structures. Some discussion should be had about having a station large enough to accommodate the Heavy Rescue unit as well in terms of a long-term solution to where to house that unit. Figure 82 shows the Travel Time performance prior to the Bayfront station being added. In Figure 83, the travel time to the Bayfront is dramatically improved. System-wide performance (Figure 84) improves as well with the addition of the Bayfront station; up 2 percent from 73 percent to 75 percent overall.

IAF for the west end is relatively good with the exception of the Bayfront and FS05 first due area. The area between FS05 and FS01 on the bay improves with the addition of this new station (Figure 85). IAF force improves for the bayfront but the system performance will actually decline by 2 percent from 87 percent to 85 percent with the closure of the Onieda station. EFF will see similar result. The percentage improves from 84 percent to 82 percent with most of the change in FS03's and FS05's area being effected (Figure 86).

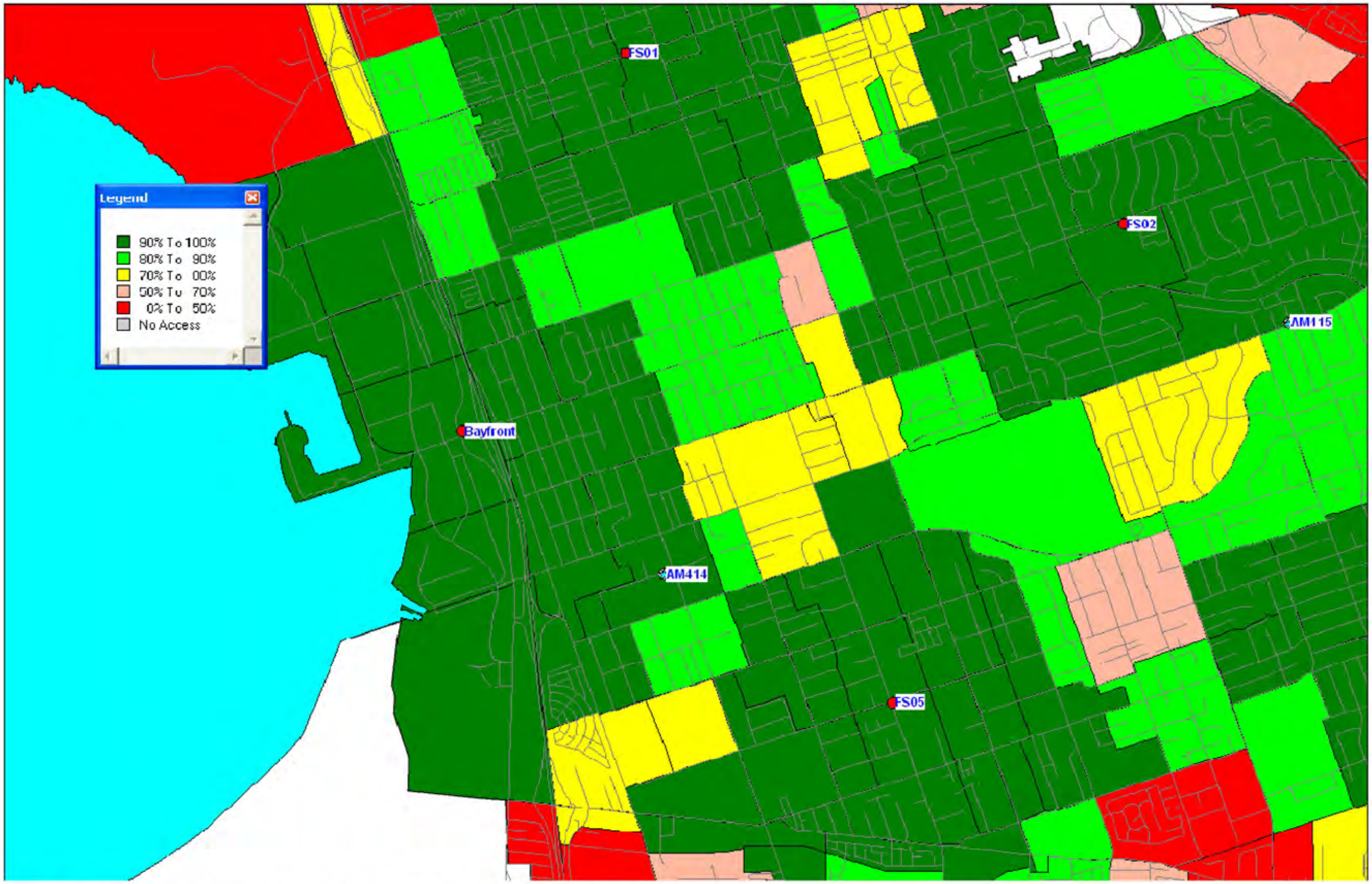
At this point (10 stations) the IAF and EFF are good in the northwest and southeast portions of the city. This is due to the staffing at FS01 and EUC and the proximity of stations adjacent to them (FS07, FS02, and Bayfront). IAF is at 85 percent due to the fact that a majority of the fires occur in the denser area protected by these stations. The same is true for EFF but now instead of assembling a crew of 4, 14 are needed so that the spacing of multiple adjacent stations are relative and not just the next closest. This is more obvious in the southeast where performance is not a good for EFF as it is for IAF due to this reason.

Figure 82: Travel Time Fire Unit Prior to Bayfront Fire Station



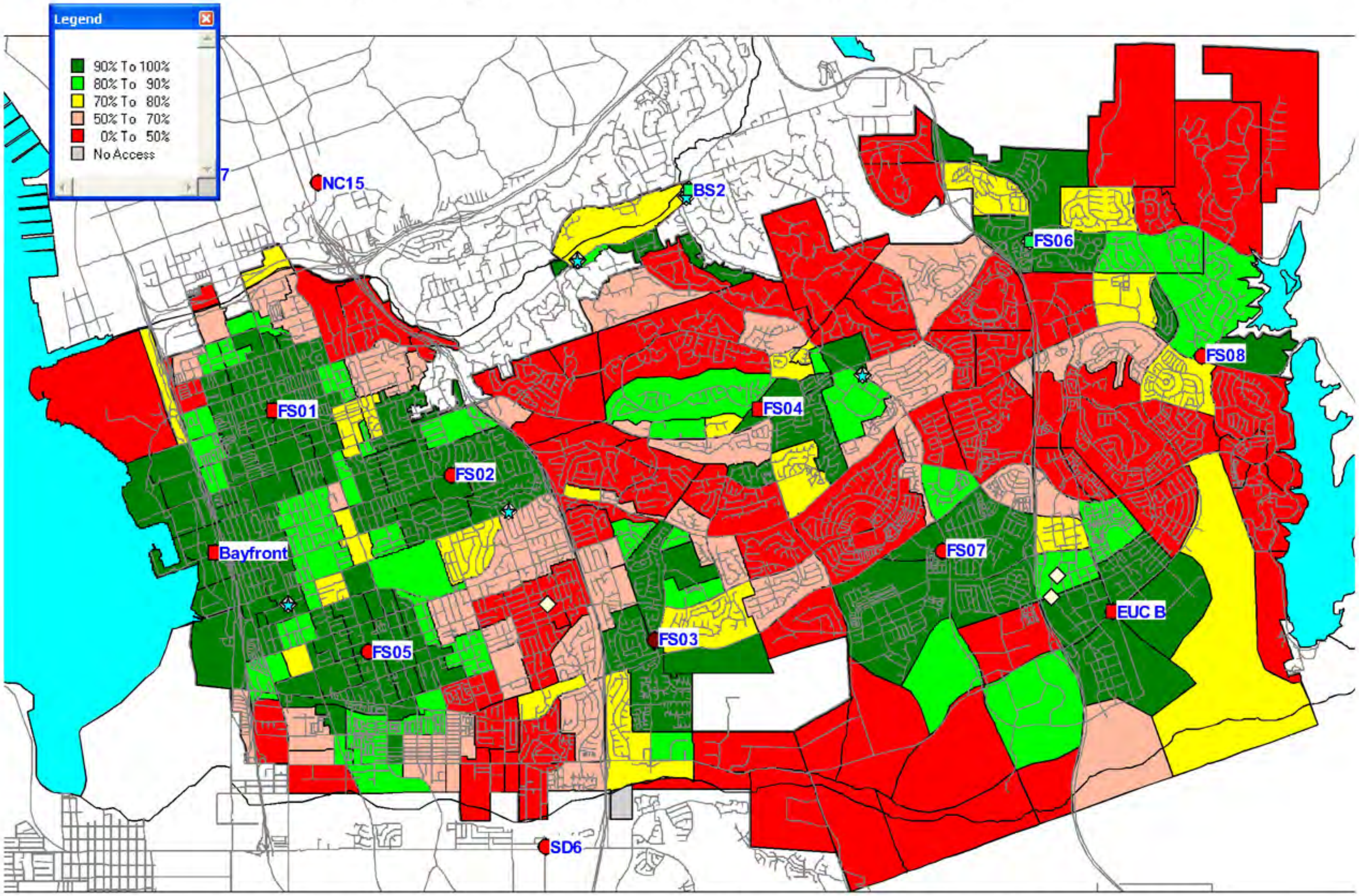
Performance Prior to Bayfront Fire Station – Travel Time (4:00)

Figure 83: Bayfront Station Added - Travel Time First Unit



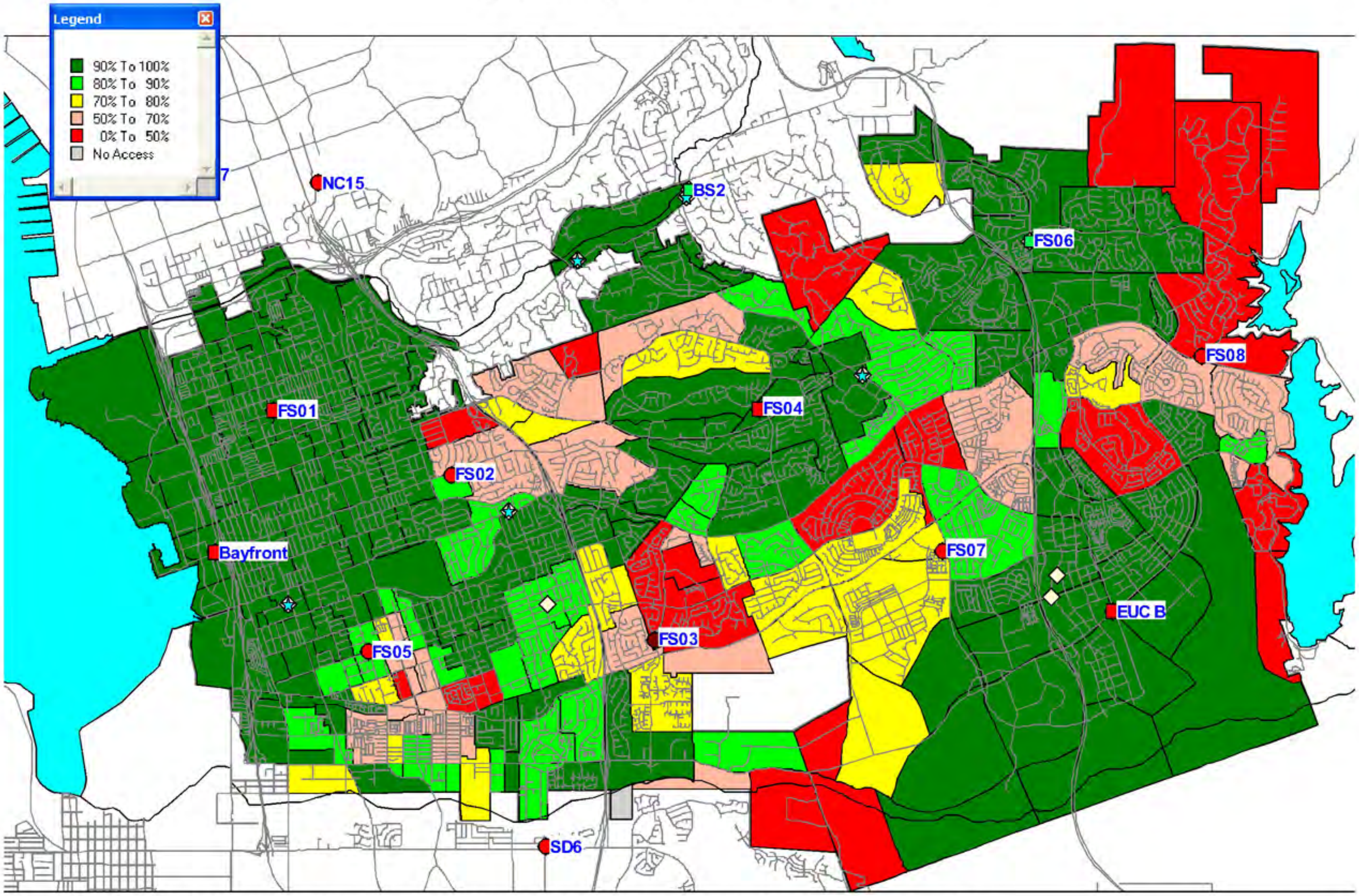
Bayfront Station added – Travel Time (4:00)

Figure 84: Bayfront Station Added - First Unit Travel System-wide



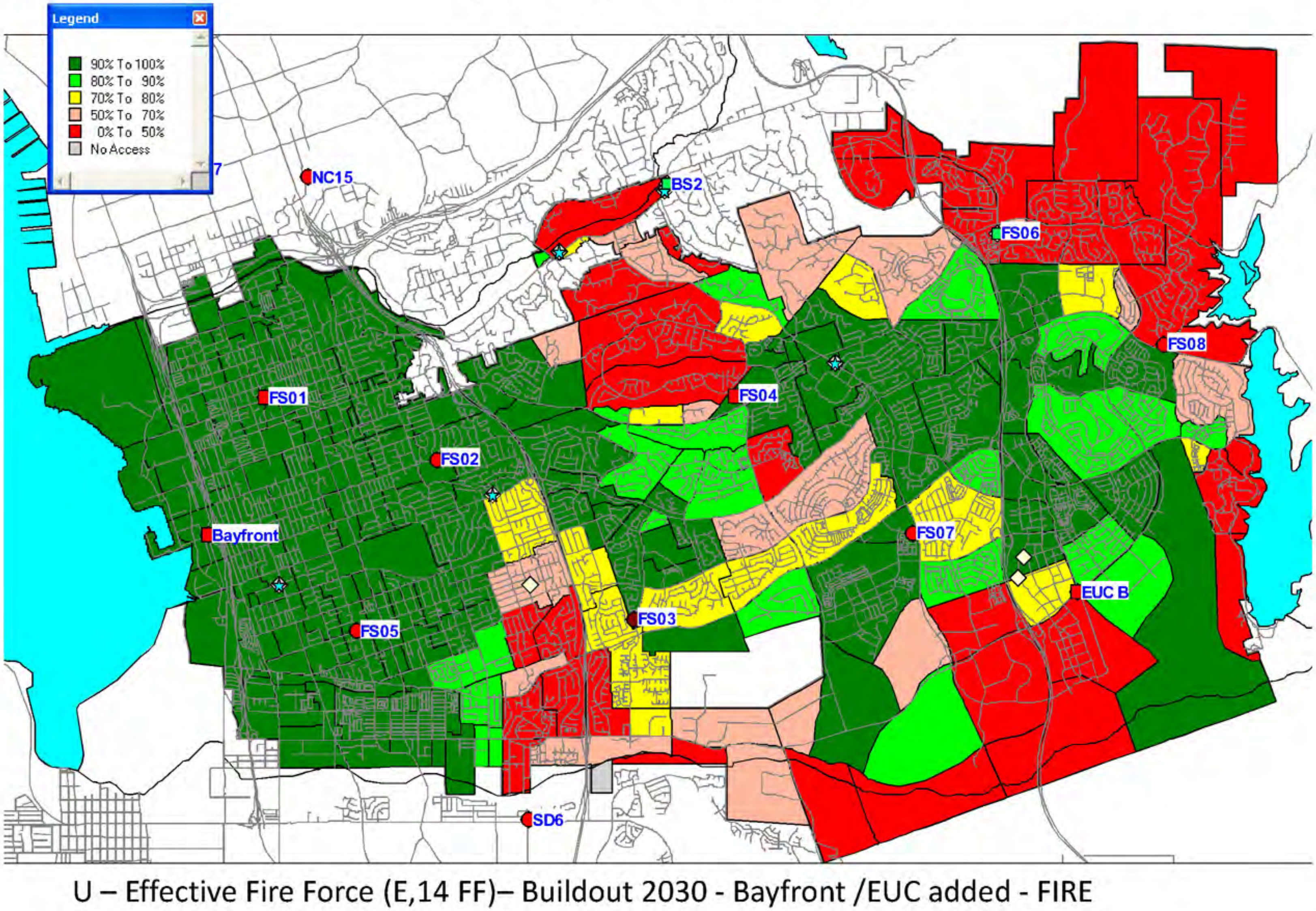
B – First Unit Travel (Enroute to Onscene) – Buildout 2030 - Bayfront /EUC added - ALS

Figure 85: Bayfront - Initial Attack Force



S – Initial Attack Force – Buildout 2030 - Bayfront /EUC added - FIRE

Figure 86: Bayfront - Effective Fire Force



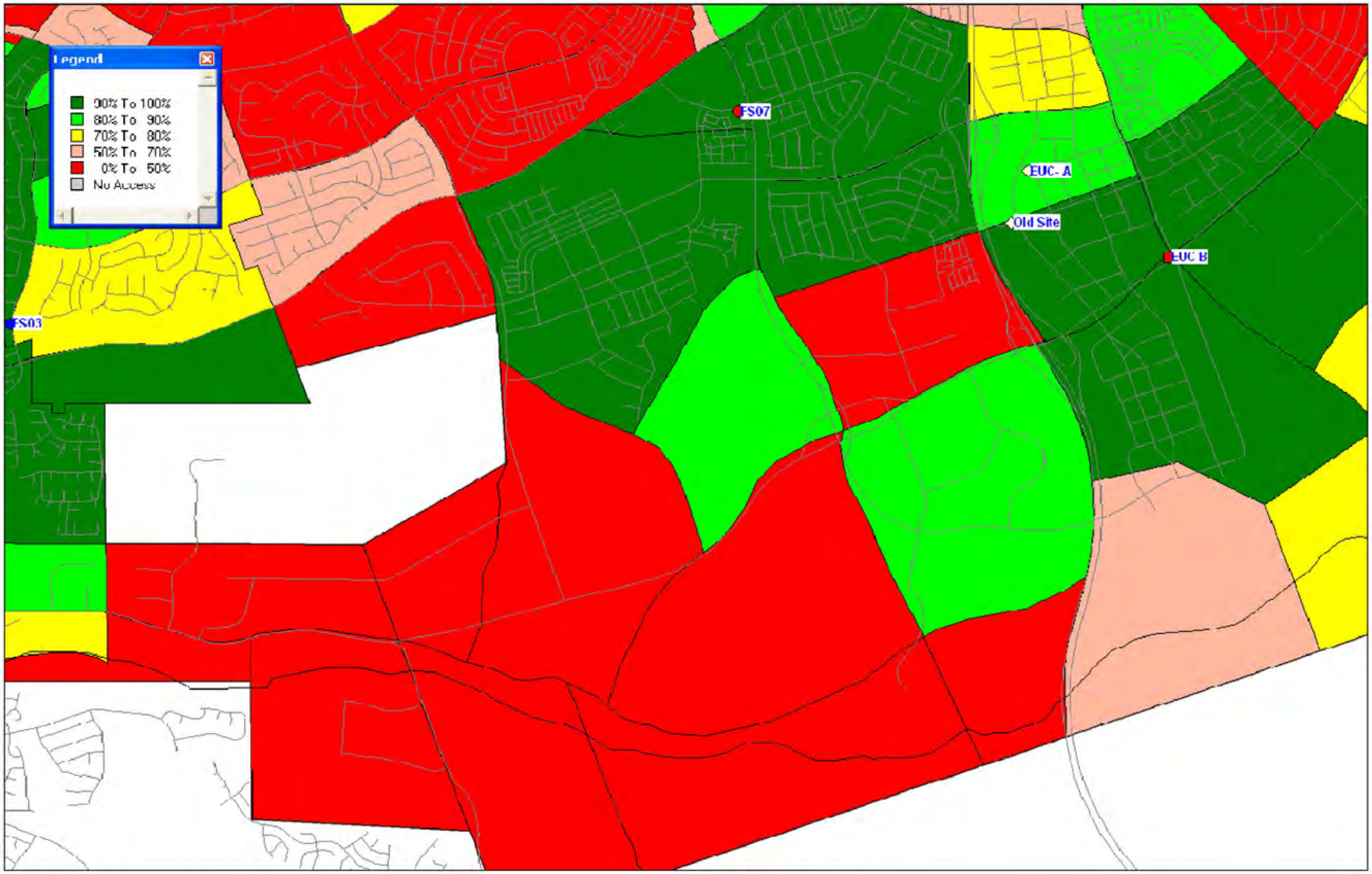
Village 8

The area east of the EUC/University will intensify under the current development plans. A fire station should be planned for the area around La Media Road and Rock Mountain Road. This station will be the primary unit for Villages 3, 4, 7, and 8. It should be built to accommodate at least two units (engine and truck). The specific site should be at La Media Road south of Rock Mountain Road

Travel time is shown prior to the Village 8 fire station in Figure 87. The travel time for the suggested site is shown in Figure 88. This site increases Travel Time - System performance to 77 percent dropping the average by four seconds (Figure 89). IAF remains the same with the truck from FS07 at the EUC station but increases by 4 percent if the truck remains at FS07 (Figure 90). However, EFF increases from 82 percent to 88 percent with the truck at EUC station site and 91 percent with the truck at FS07 (Figure 91). As stated before, the truck should remain at FS07 until a third truck is placed into service at which time trucks should be located at FS04 and the EUC station.

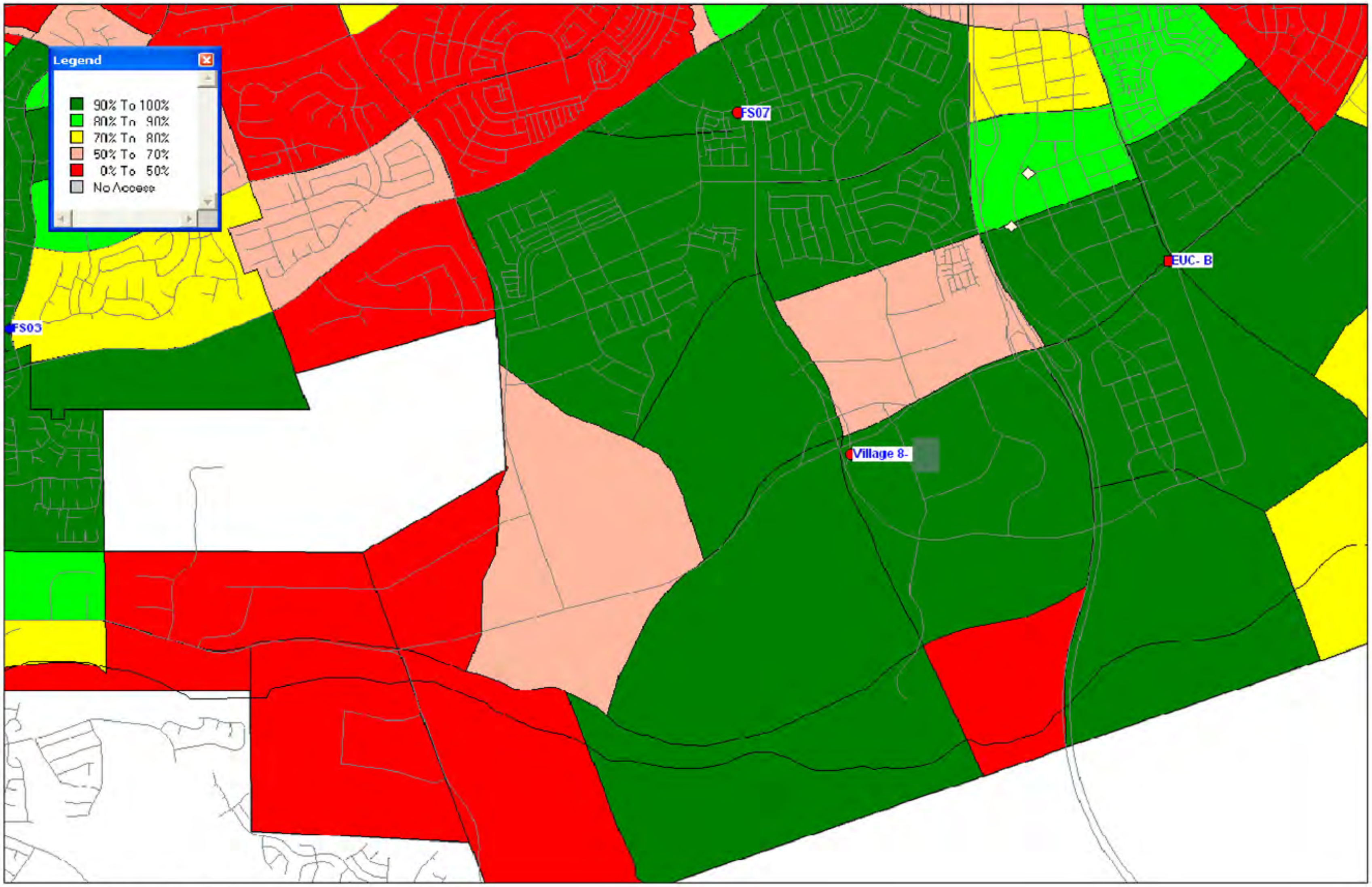
The configuration of the 11 stations is detailed in the first due map (Figure 92) that shows that size and balance of the fire stations area of coverage. The configuration is as close to optimal as possible given the infrastructure and topographical challenges that exist in some parts of the city.

Figure 87: First Unit Travel Prior to Village 8 Station



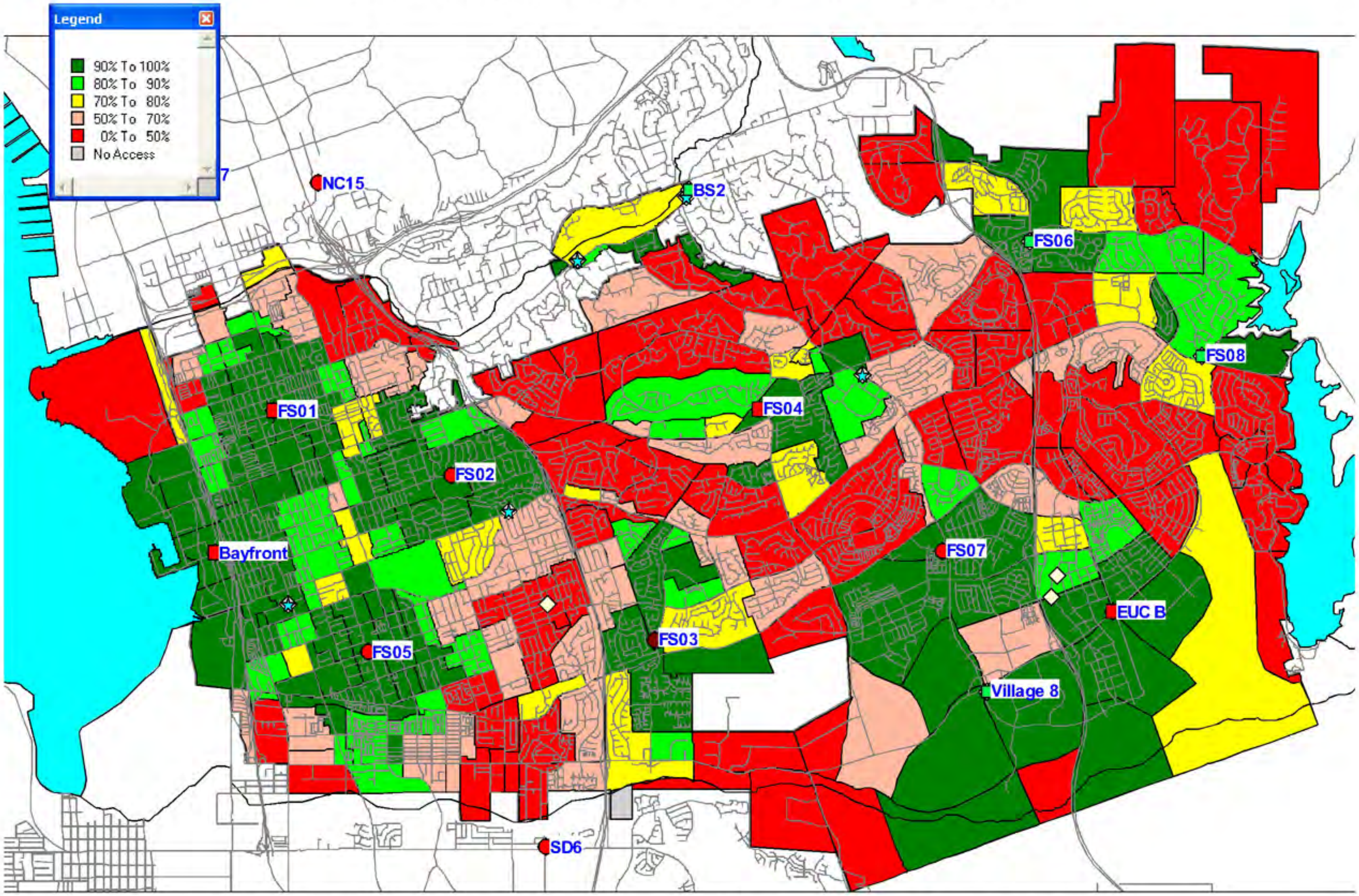
Performance Prior to Village 8 Station – Travel Time (4:00)

Figure 88: Village 8 Site - Travel Time



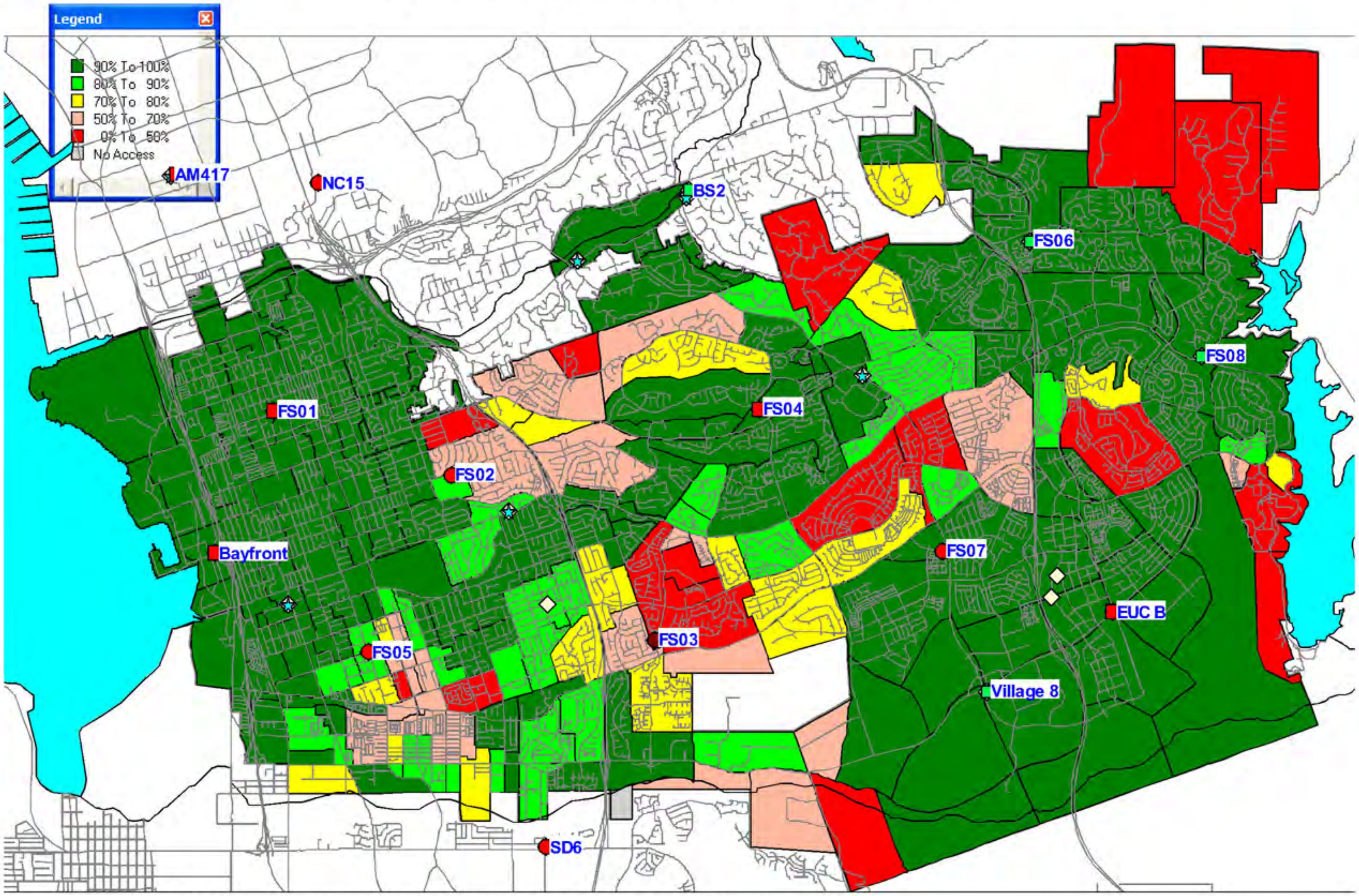
Village 8 – Travel Time (4:00)

Figure 89: Village 8 Station Added - First Unit Travel System-wide



B – First Unit Travel (Enroute to Onscene) – Buildout 2030 – ALS - 11 stations

Figure 90: Village 8 Station Added - Initial Attack Force



S – Initial Attack Force – Buildout 2030 - 11 stations FIRE

Figure 91: Village 8 Station Added - Effective Fire Force

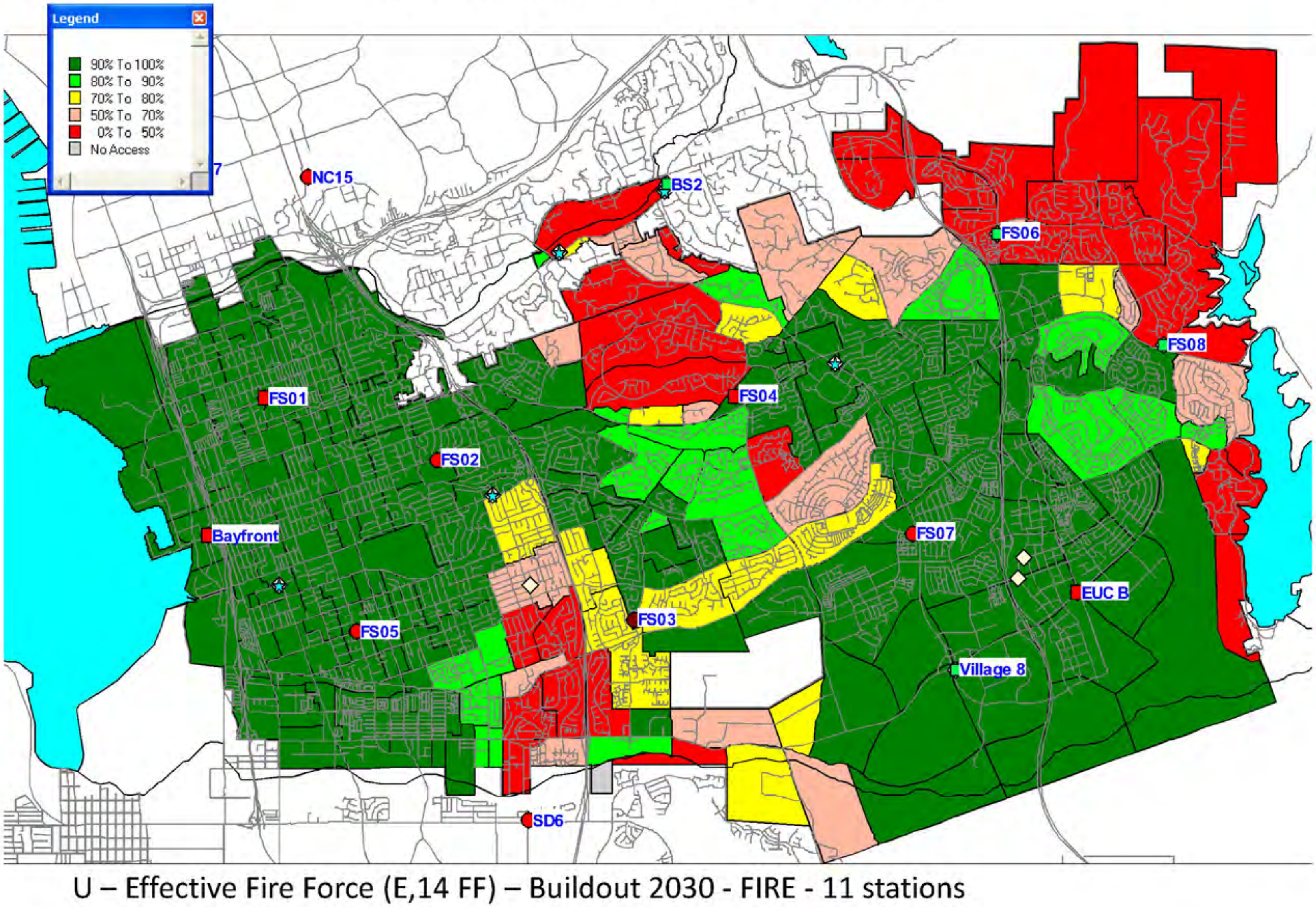
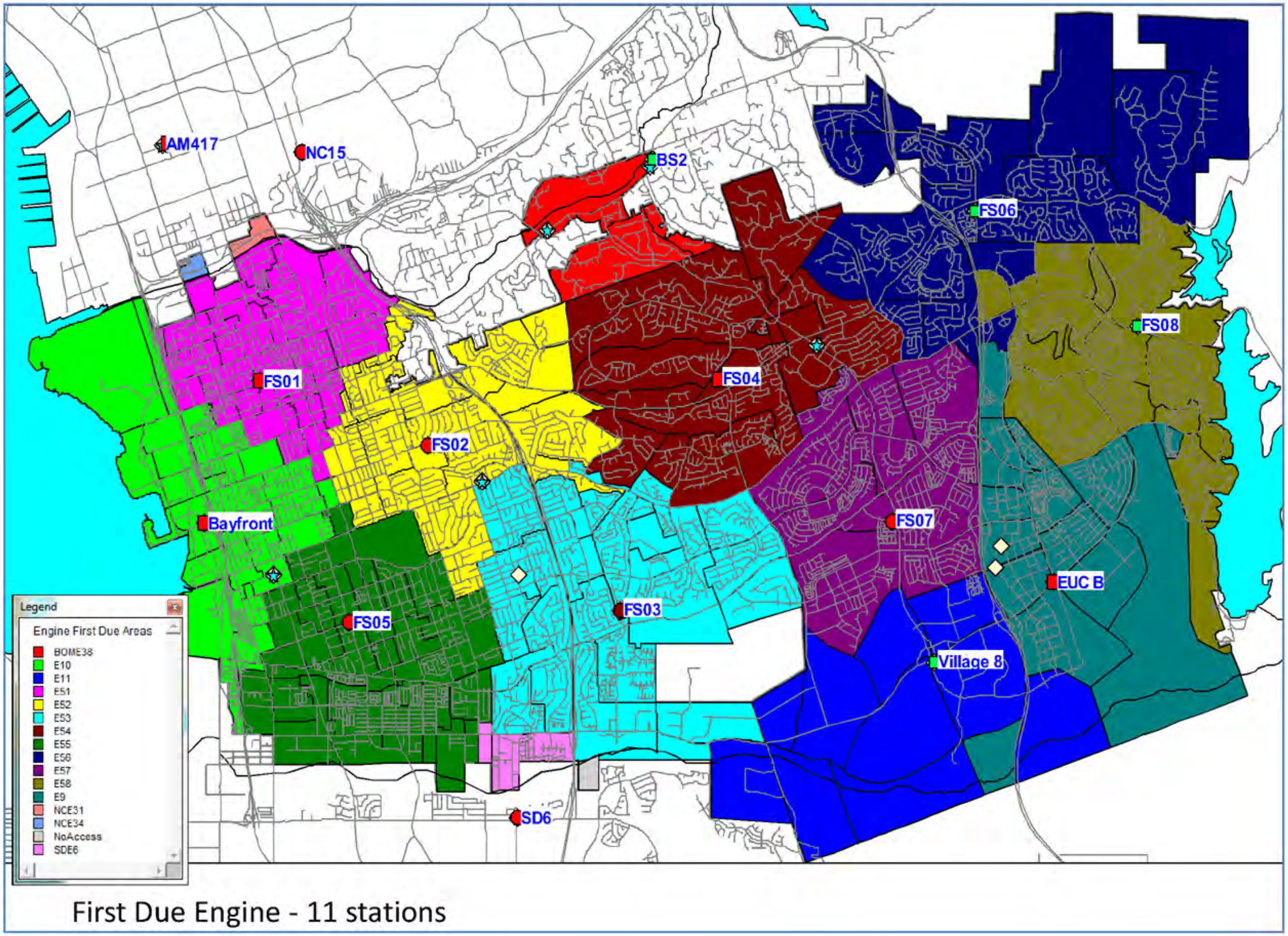


Figure 92: First Due Engine Areas - 11 Station Configuration



Resort Focus Area

The area to the east of the lake is not in the current model. It is not possible to analyze it in the same manner as has been done for the other development area. There are a few reasons for this. First, streets and infrastructure are not known to a point where reliable assumptions can be made for the model. Second, type of structures and use are not well enough established to be able to project workload. Third, the impact of services to be provided to adjacent land uses outside of the City's sphere of influence are not known or planned at this point and so it has to be assumed that no services beyond those provided today are going to be in place. These factors combine to paint a picture that is very negative in terms of service provision needs and costs. In light of this, the analysis for this area was done simply on time and distance and with the facts that are known.

The center of the Resort Focus Area adjacent to the lake is approximately three miles from FS08. This is nearly twice the distance that will produce a 90 percent travel time performance at 4:00. The travel distance from FS08 for 1.5 miles is shown in red in Figure 94. Some areas of the development area could be up to five miles from FS08. In Figure 95, the distance to each of the existing and proposed fire stations is shown. These are converted to time in the table below:

Figure 93: Distance to Existing and Proposed Stations

Station	Distance	Time
FS08	2.87 miles	5:32
FS06	5.03 miles	9:12
EUC	5.56 miles	10:06
FS07	6.69 miles	12:01
VILLAGE 8	6.90 miles	12:23
FS04	7.28 miles	13:02

As can be seen from the table above, assuming a new fire station in the Resort Focus Area, the second engine would be over 5.5 minutes away, the third engine over 9 minutes, and the first truck (with truck at EUC or FS07) would be 10 to 12 minutes away. An EFF would not be assembled till the arrival of the truck/battalion chief. IAF is very critical here with the second arriving unit over 5.5 minutes behind the first. As was shown in the CTA, the fire attack team cannot enter (with the exception of making a rescue) to attack the fire until that unit arrives as long as only three personnel staff the unit at the Resort or this station has four personnel and/or two or more units. Future planning for this area should be for a station capable of housing at least two resources.

Figure 94: Resort Focus Area Existing Coverage

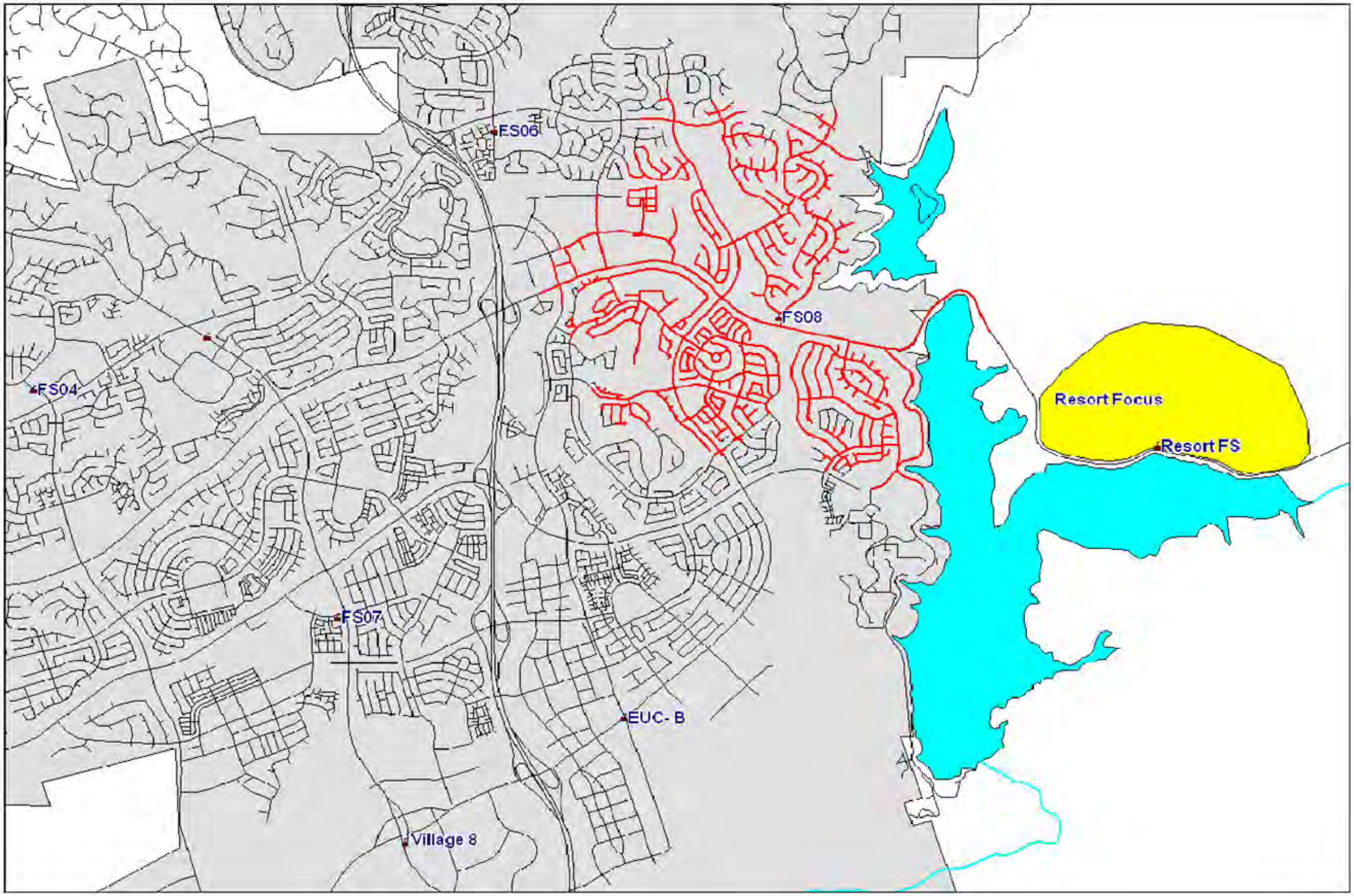
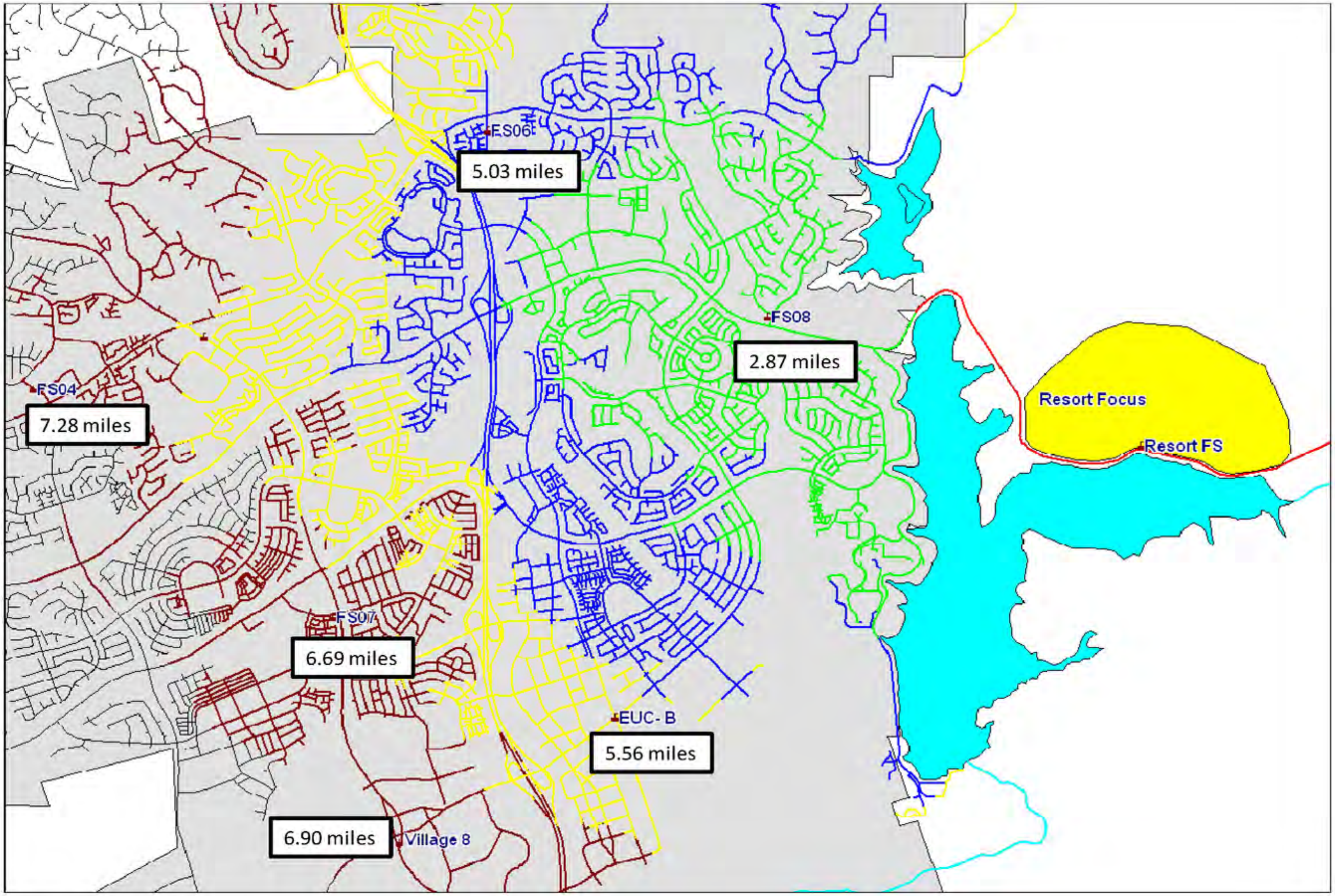


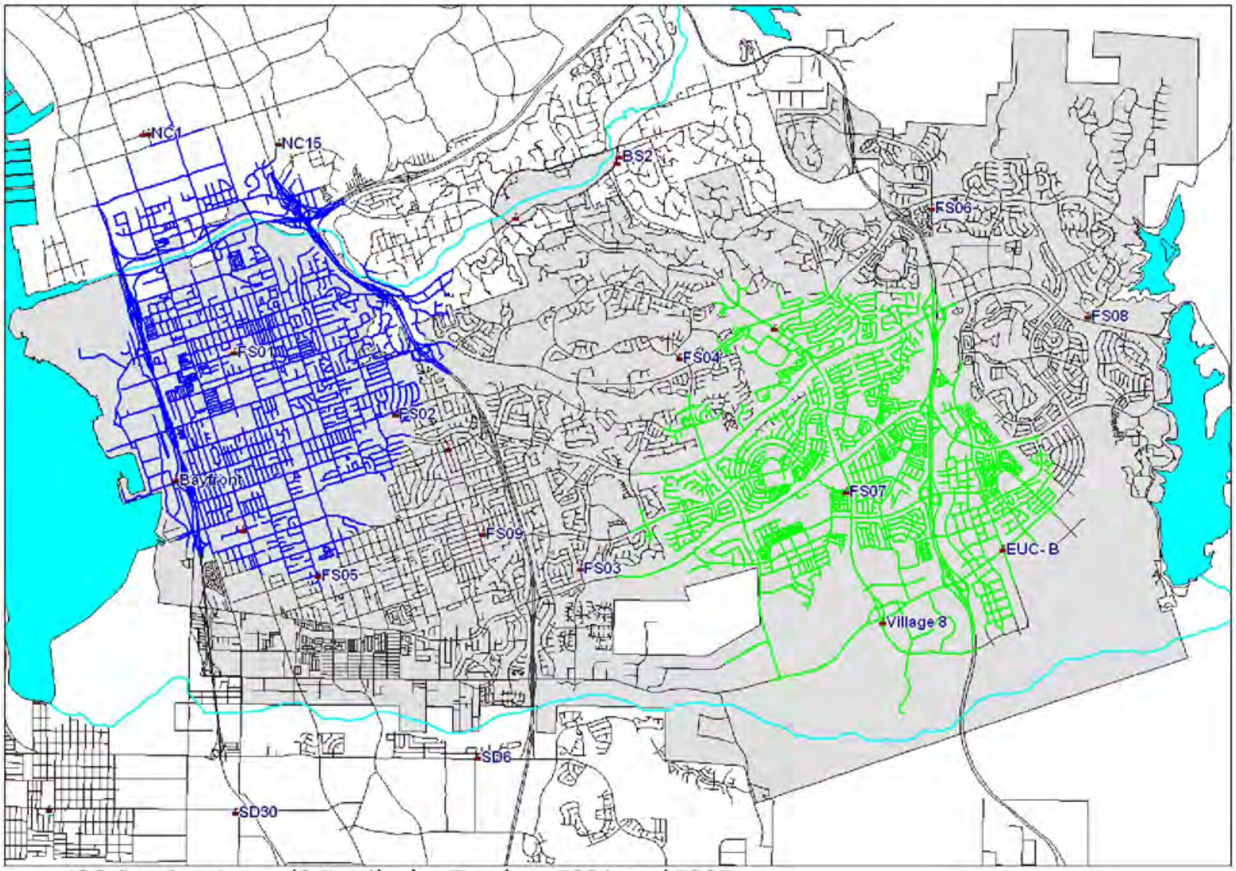
Figure 95: Resort Focus Area Travel Distance



Additional Truck Company

Current truck coverage is provided by two city truck companies. Using the ISO standard of 2.5 miles for truck coverage, the city is properly serviced as shown in blue (T51) and green (T57) areas below. San Diego City Truck 29 does not cover any of the city.

Figure 96: Current Truck Coverage (2.5 miles - ISO Standard)

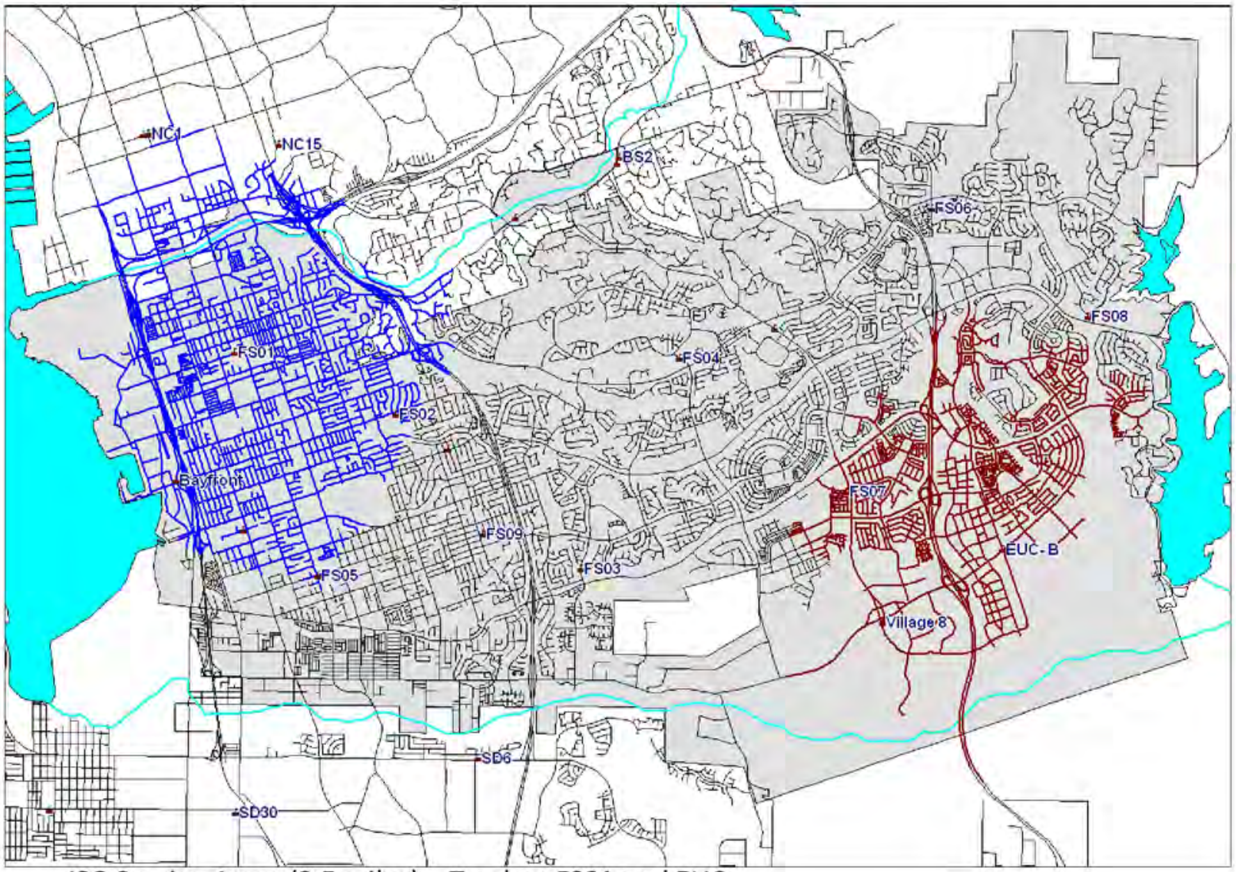


ISO Service Areas (2.5 miles) – Truck at FS01 and FS07

Large areas of the city are not protected within this standard. Figure 97 illustrates that moving the truck from FS07 to EUC (shown in brown) while maintaining two trucks is not a good idea. No new areas are provided protection while large areas are uncovered from the protection area. The truck's service is area is pushed up against open space and topographic features which limit its effectiveness as a scare resource.

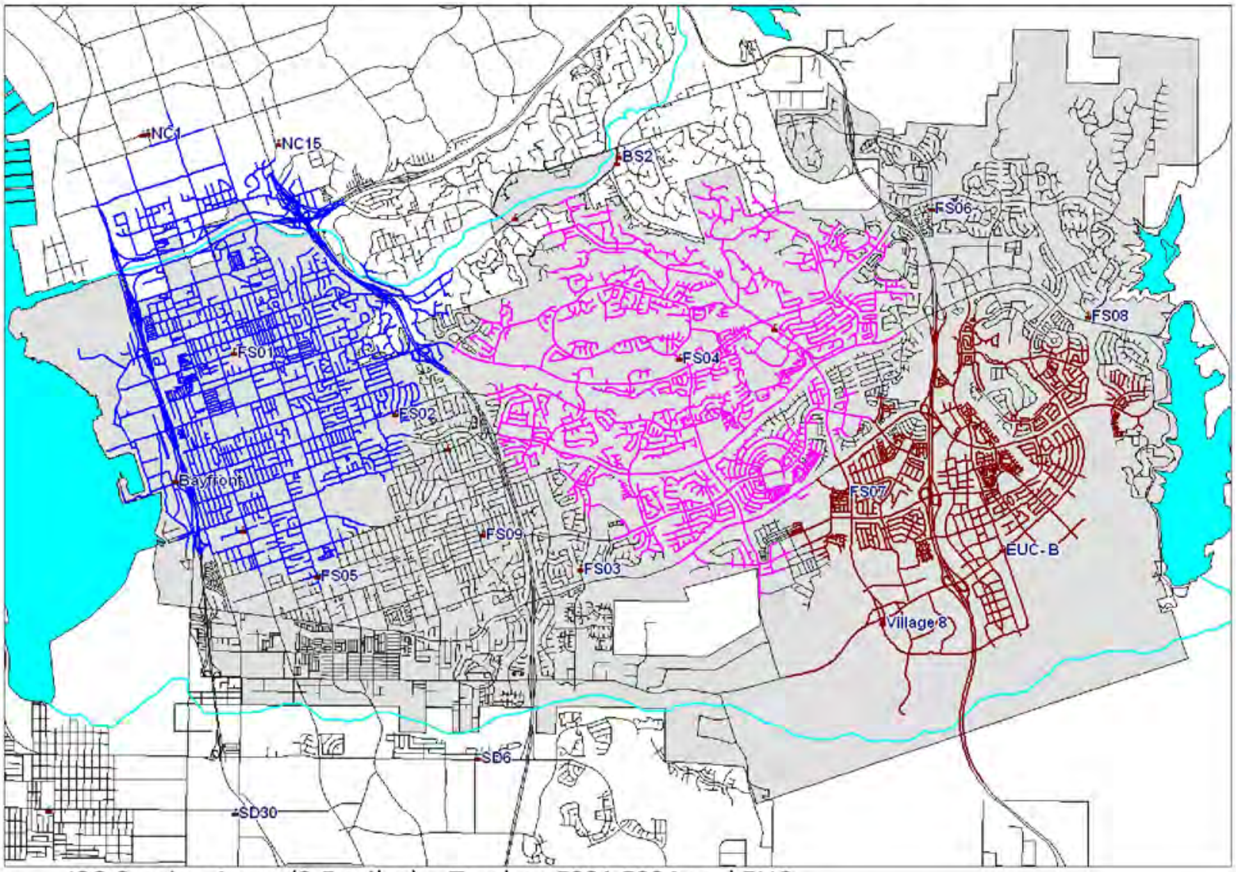
However, when a third truck is added to the system at FS04 (purple), not only is the majority of the city protected, the balance is achieve by moving the truck from FS07 to EUC, as shown in Figure 98. If a travel distance of four miles is used (eight minutes), the coverage improves significantly, as shown in Figure 99. San Diego T29 (yellow) still plays little to no role in coverage for the city.

Figure 97: Truck Coverage with EUC Shift



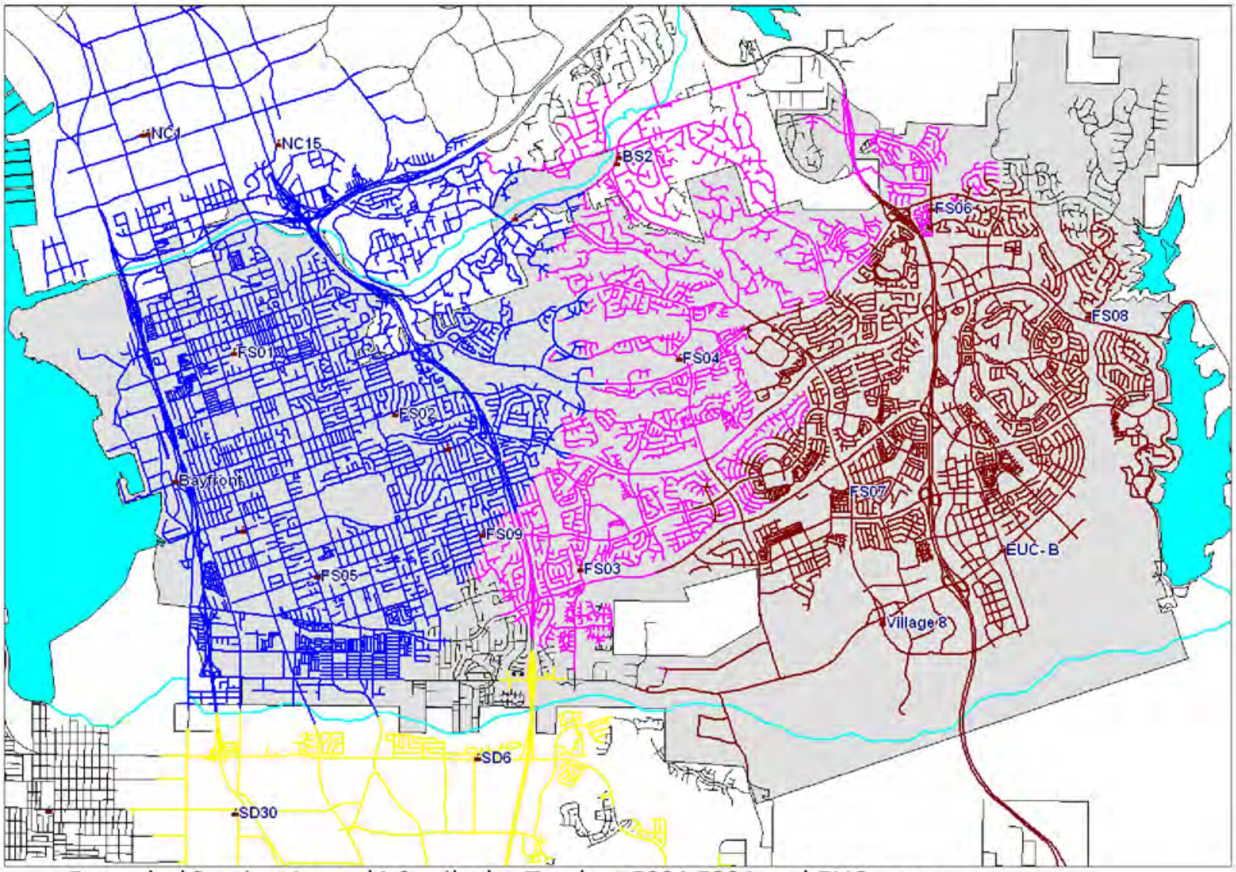
ISO Service Areas (2.5 miles) – Truck at FS01 and EUC

Figure 98: Three-Truck Configuration (2.5 miles)



ISO Service Areas (2.5 miles) – Truck at FS01 FS04 and EUC

Figure 99: Three-Truck Configuration (Four Miles)

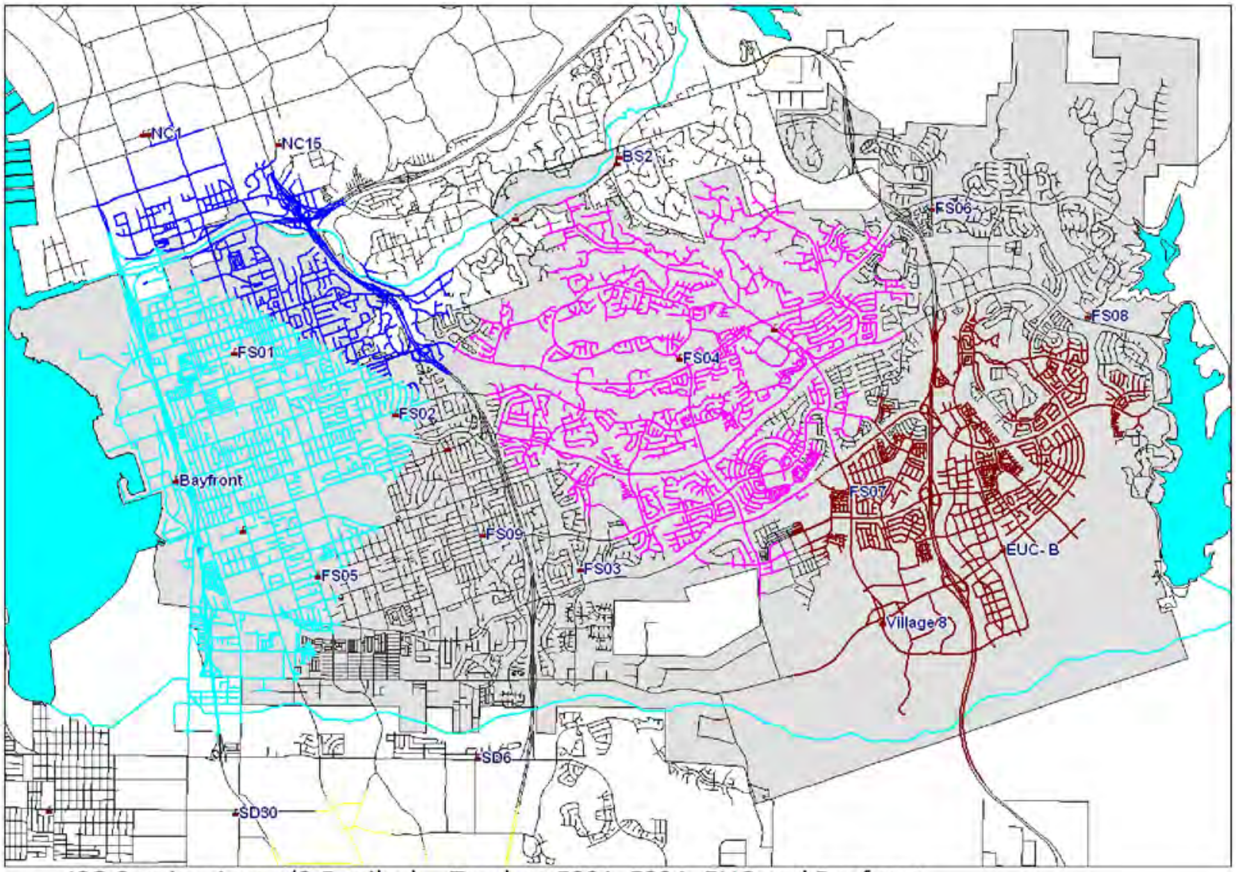


Extended Service Areas (4.0 miles) – Truck at FS01 FS04 and EUC (SDT29 in yellow)

A third truck company should be added to the delivery system when EUC needs a second unit due to call loading (approximately 3,500 calls for service by engine at EUC fire station). When this trigger is reached, the truck at FS07 should be moved to EUC and a truck added at FS04. This action will keep EFF to 92 percent system-wide and increase IAF to 88 percent system-wide.

The additional risk to be added to the Bayfront area will likely require the addition of a truck at the Bayfront station as well. This is primarily due to the fact that the trucks at FS04 and the EUC station are too far away to add the needed manpower, equipment, and aerial capabilities that will be needed for the midrise and highrise buildings that will be in this development area. The coverage area for this fourth truck is shown in Figure 100.

Figure 100: Truck Coverage from Bayfront Station



ISO Service Areas (2.5 miles) – Truck at FS01, FS04, EUC and Bayfront

Conclusions and Recommendations

Distribution

The Fire Department Goal of "first unit in four minutes travel time at 90 percent" is difficult to achieve. The modeling used here projects 24 stations are needed due to the nature of the street network combined with the sprawling nature of the development. First unit travel performance is achieved to the 77th percentile when the EFF is achieved to the 90th percentile (11 stations). Due to the extreme impact of tripling the number of fire stations, specific locations have not been detailed in this report. It should be noted that the 90th percentile can be achieve in five minutes when the EFF is achieved at the 90th percentile. Some thought and discussion should be directed at revisiting the four-minute timeframe in light of the analysis that has been conducted or to using the IAF and EFF standards are the primary goals.

Concentration

In order to achieve the EFF in eight minutes travel time at 90 percent today, it is necessary to increase the number of fire stations to 11 with three truck companies and two battalion chiefs. With future increases in workload, the number of stations is not expected to increase (either with the JPB proposal or the university). Development may shift or change and will likely have slower periods from time to time. Phasing of stations will need to match the development. The resort area has not been used in this calculation and will remain an outstanding issue until more specific information, timing and infrastructure are determined.

Station Locations (Current and Proposed)

FS01 – This station should be reconstructed at its current location with the ability to house three resources.

FS02 – The location that best maximizes this station is within 0.25 miles of Hilltop Drive and Whitney Avenue, with locations closer to H Street modeling better. This relocation will better serve the areas east of FS01. Access to the freeway is good as well. The current site of FS2 is acceptable, but not optimal. A new site could be considered in the long-range planning.

FS03 – Relocating this station to Olympic Parkway and Oleander Avenue is the optimal location. Any site within 0.25 miles of this intersection is acceptable. This area balances area coverage with access to the freeway. The current location is acceptable but will not increase performance on rescue calls and will not house two resources if needed. The new site could be considered in the long-range planning.

FS04 – This station should be expanded to ensure that it can adequately house an engine and truck in the future. Since the trigger for this action in the call loading in EUC's first due, there is time to plan for this need and make the improvement with future improvements to the training grounds.

FS05 – Fire Station 5 is a candidate for relocation if the current site cannot be reconstructed to house additional resources. It could be relocated to the south approximately one-half mile. The optimal location would be 4th Avenue and Orange. This should be a future large station that will house an engine and the possibility of a truck or squad.

FS06, FS07, and FS08 – current sites and configuration are acceptable.

FS09 – Current location is acceptable but the station should be closed and the engine currently housed here relocated to FS03 when the USAR is collocated at the Bayfront fire station.

<u>New Fire Stations</u>

EUC – All three possible sites are in development areas. Site B is optimal. Planning with the developer should begin to move the current site to Site B.

Bayfront – This station should be constructed near the intersection at J Street and Bay Boulevard. This area is currently underserved, and given the expected growth in this part of the City, plans for this station are underway and should continue.

Village 8 – The exact location of this station will not be known until more precise plans are available for the development in this area. This station should generally be at La Media; south of Rock Mountain Road.

<u>Future Development Outside of Current City Boundaries</u>

Resort – This is a new station that may eventually house multiple companies. A site should be found within one-quarter mile of the center of the Resort Focus Area. A rural standard may need to be adopted by the city for this area and the Proctor Valley/San Ysidro Mountain Districts.

Initial Attack Force (IAF)

As indicated earlier, with the current staffing, a second unit must arrive to assemble an IAF. In the critical task analysis section of this report it has been established that a three-person crew will take approximately 2.5 minutes (2:30) longer to be prepared to enter a burning structure. One in five calls (20 percent) have the second engine arriving three minutes after the first and for one in ten calls (10 percent) the second unit is nearly four minutes (3:49). These delays allow the fire to gain a large amount of momentum that will require even more resources to control and significantly reduce the chances of survival for occupants and the ability of the fire department to limit damage.

The only deployment that guarantees a rapid IAF on every fire will be to staff each unit with four personnel. Until system-wide staffing is at four persons per unit, it is possible to indicate which units have more exposure to this issue. Stations with two resources are not as critical as standalone units. Stations on the perimeter (FS04, FS06. FS08, EUC, and VILLAGE 8) have a greater chance of not having a second unit in a timely manner. Four-person crews at these locations should be given serious consideration.

Effective Fire Force (EFF)

The current performance for EFF is 82 percent (87percent in model). The 2030 workload and additional area to be covered reduces that performance to 78 percent. That reduction is effective reversed with the addition of EUC, however, as staffing and stations are increased to deal with First Unit Travel and IAF, EFF rises to over 90 percent. To accomplish this, an additional truck needs to be added and the EUC, BAYFRONT, and VILLAGE 8 fire stations need to be constructed to get to the 90th percentile.

Ancillary Issues

Dual use apparatus/cross staffing is a concept that can be used successfully for wildland engines, water tenders, and other specialty units. The ability of the department to quickly field wildland resources is important to the probability of extinguishing these fires while they are still small enough to do so without a large number of resources. Consideration in the construction of fire station for the parking for specialty apparatus should be undertaken and space for at least three or four wildland specific resources (brush trucks, water tender, patrols) should be incorporated into the new fire stations that are being projected.

Appendix A: Standards of Cover

Much of the following materials have been adapted or directly quoted from the publication, *Creating And Evaluating Standards Of Response Coverage For Fire Departments©*, 4th Edition, Commission On Fire Accreditation International, Inc., Chantilly, VA. Additional materials have been added by Ron Coleman and Gene Begnell, two of the co-authors of the above noted publication.

History

In the early days of the fire service, there was not much reason to talk about response time. In the days of hose carts and bucket brigades, fire stations were based more on the limitations of the fire truck, or the means used of hauling the heavy equipment over distances. With hand-operated equipment, the distance was obviously limited. When the steam engine came into service, horses were used to pull the equipment from the station to the scene. In areas where full-time departments were created, generally in the large communities, the placement of fire stations became a public policy decision process. This was the first instance where time and distance were really given consideration in selecting the locations for stations. This required that fire stations be placed using some type of criteria.

Beginning around 1850, with the creation of full-time fire departments, fire stations were originally staffed based on the existence of the earlier stations, which were essentially based upon neighborhoods and the location of volunteers. When new stations were required, one of the very first criterion was the idea that multiple fire stations needed to be spaced sufficiently apart so that the overall community was covered, and yet close enough together to be able to support one another. Because this criterion was based upon the use of horses to haul the equipment, it was natural to look to the capacity of these horse teams to arrive at an emergency in a relatively short time. Whether it was by intent or by accident, the numbers that were arrived at were fairly easy to understand: how far could a good team of fire horses haul a steamer in five minutes? At a gallop, horses pulled steamers about 1.5 miles in five minutes. This practice was discussed in the fire literature at the time, and was a widely accepted practice.

For more than 40 years, the method of choice for responding was to continue to use horses. The fire service adopted automotive fire apparatus to replace the horses once the technology had been proven to be reliable. However, the transition was not short, nor was it universal.

There were many fire departments that operated horse-drawn apparatus for 25 years after the introduction of internal combustion engines. Therefore, the existing prevailing practice of site planning for fire stations was based upon the common practice of the 1.5-mile radius as a rule of thumb. In fact, the practice was also institutionalized by fire agencies that continued to use the criterion in spite of upgrades of roadways and traffic circulation systems.

Influence of National Organizations on the Process

With the creation of the fire grading system by the National Board of Fire Underwriters, the fire service was almost immediately affected by that group's establishment of an evaluation system that was somewhat based upon science and somewhat based on past practices. For example, the work that was done to create fire stream hydraulics was based upon very specific studies and considerable data. The fire flow figures developed for various construction types were based upon studying actual fire losses. The data was not as scientifically verifiable, but it was systematic. The grading schedule was designed to prevent urban conflagration, not to serve the day-to-day activities of a fire agency. Among the concepts incorporated into this system was the assumption that the 1.5-mile fire station radius was appropriate for use in that context.

There is very little literature describing fire station siting studies from the early 1920s until the 1960s. At that time, there was an interest in the question of how to site and staff fire stations in heavily urbanized and highly impacted fire service agencies. Beginning in 1968, the Rand Institute developed a research project to study the variables of fire station response. This included a review of both time and distance factors. The Rand studies were too complex and difficult for local government, and fire service personnel, to fully understand.

One group that did pay attention to this research was the International City/County Management Association (ICMA). As a result of a series of exchanges between the organization and the insurance industry, a concern was expressed that the insurance industry's criteria were antiquated and not consistent with contemporary issues facing the fire service. Several documents were produced challenging the assumptions of the insurance industry relative to fire station locations and methodologies.

Role of International Association of Fire Chiefs and ICMA

In 1986, the International Association of Fire Chiefs (IAFC) began developing the concept of fire department self-assessment after adopting a proposal established by Chief Ron Coleman, IAFC second vice president. The IAFC Executive Board adopted the creation of a task force to explore the concept. The intent of this project was to develop a more uniform method of evaluating fire defenses. The program's intended result was the development of an accreditation system for organizations that had met all of the categories, criterion, and performance indicators established within the system. The first meeting was held in Washington D.C. at the IAFC annual conference. The committee eventually grew to more than 50 persons, and was in the developmental process until 1997, when the Commission on Fire Accreditation International Inc. (CFAI) was formed. The Accreditation Task Force instituted a study of the methodology, which was introduced in the first edition of its *Fire and Emergency Service Self-Assessment Manual.*

ICMA entered into a memorandum of agreement with the IAFC to advocate the concept of self-assessment. The CFAI Board of Trustees was established in 1997. The commission was created after nominations were received from agencies that were eligible to have a seat on the commission. The *Fire and Emergency Service Self-Assessment Manual* was published and copyrighted. The commission reviewed and granted accreditation to the first five agencies that had successfully completed the entire process.

European Practices

When CFAI began its research into the concept of having a standardized model for reviewing fire department deployment, it discovered that this concept had been in practice in many European fire departments since the end of World War II.

Fire station location, in other parts of the industrial world, developed under slightly different conditions. In Europe, as a result of more national involvement of the provision of fire services, especially in the aftermath of World War II, there was a desire to set some standards. Right after World War II, the British fire service adopted a concept called *Standards of Response Coverage*. Between 1950 and the early 1980s, the British fire service adopted a series of standards that dealt with a wide variety of conditions ranging from rural to urban settings.

Systems Approach

The historical Standards of Cover (SOC) systems approach consists of the following eight components.

1. Existing deployment
2. Risk identification
3. Risk expectations
4. Service level objectives
5. Distribution
6. Concentration
7. Performance and reliability
8. Overall evaluation

Together, these eight components provide the groundwork for adoption of system performance measurements. Current practices are changing the process slightly, with additional new components, which were present, but subtle before. Current thinking uses the following:

1. Overview of Existing Deployment

All agencies have an existing policy, even if it is undocumented or adopted by the locally responsible elected officials. Originally, stations and equipment were situated to achieve certain expectations. How and why they were sited needs to be historically understood, described, and contrasted to proposed changes. A review of the facilities, equipment, and personnel in the existing system needs to be provided. One key issue in this phase is to determine or document services that are provided by the organization. Traditionally, fire departments have provided fire and rescue service, but many departments today also provide EMS, hazardous materials, and specialized services such as ARFF (aircraft), marine, or wildland services.

2. Risk Identification and Assessment

Risk assessment consists of two key elements:

- Probability: The likelihood that a particular event will occur within a given period of time. An event that occurs daily is highly probable. An event that occurs only once in a century is very unlikely. Probability is an estimate that an event will occur, and a prediction that it will be very close by in time, or sometime off in the future.
- Consequence: Which has two components - life safety (the amount of emergency personnel and equipment to rescue or protect the lives from life-threatening situations) and economic impact (the losses of property, income, or irreplaceable assets).

Risk Factors

In order for a fire agency to make specific observations about the scope and complexity of its risk areas, it must have conducted a risk assessment. Among the key risk factors to be evaluated are:

- Population/demographic factors such as density or aged populations.
- Building/occupancy factors such as the relative risk to life and property resulting in a fire inherent in a specific occupancy or in a generic occupancy class.
- Environmental factors such as floods zone, wildland fires, topographic issues, weather, and climatic conditions.
- Infrastructure including transportations systems (road, rail, water, and air), water systems, communications, and support systems (traffic control, flood control, storm drains, levee systems, etc.)
- Demand/service zones – areas used to define or limit management of a risk situation.
- Community: Defined as the overall profile of the community based on the unique mixture of individual occupancy risks, demand zone risk levels, and the level of service provided to mitigate those risk levels.

Risk must be assessed for each service provided.

3. Risk Expectations

Before performance measures can be developed for a community, it is necessary to determine the expectations of the citizens within the community. For example, fire protection for a community could range from a single fire extinguisher placed at the center of town for everyone use, to having firefighters stationed at every corner. While neither of these extremes is likely, the answer for each community lies somewhere in between the two extremes. The point at which it lies is a community decision, and will likely be different in every community. The level of consequence that is *acceptable* to the community will dictate the level of resources that community is willing to provide to see that the *acceptable* threshold is not exceeded.

After understanding the risks present in the community, what control measures do the citizens and elected officials expect? For example, does the agency confine the fire to the compartment of origin, area of origin, floor of origin, or building of origin? Some agencies in sparsely populated areas with long response times of 30 minutes or more might have to accept an exposure level of service, where the building fire does not spread to the adjoining forest and start a conflagration. In EMS, the department might expect to get a trauma patient to the designated trauma center within the first hour.

4. Service Level

Typically, the level of service areas would be urban, suburban, rural, or undeveloped. This does not stop a community from combining areas or developing new ones. Each risk category found in a community should have an outcome expectation developed for it. Risks other than structure fires are typically EMS, special rescue such as confined space, hazardous materials, airports, and airplanes, etc. Deployment is measured and typified from two concepts, distribution and concentration, which are influenced by response time, and create an effective response force for *each risk category for each service provided in each level of service defined...*

5. Measurements of System Performance

Distribution is locating geographically distributed, first-due resources for all-risk initial intervention. These station location(s) are needed to assure rapid deployment to minimize and terminate average, routine emergencies. Distribution is measured by the percentage of the jurisdiction covered by the first-due units within adopted public policy response times. Policies include benchmarks for intervention, such as arrival prior to or at flashover, or arrival on EMS incidents prior to brain death in cardiac arrest. From risk assessment and benchmark comparisons, the jurisdiction will use critical task analysis to identify needed resource distribution and staffing patterns.

A sample distribution policy statement could be:

> *For 90 percent of all incidents, the first-due unit shall arrive within five minutes total reflex time. The first-due unit shall be capable of advancing the first line for fire control or starting rescue or providing basic life support for medical incidents.*

Distribution statements have some very specific grammar and structure. They must have a fractile performance measure and a time measure—either total reflex or travel.

Concentration is defined as the spacing of multiple resources arranged (close enough together) so that an initial *effective response force* can be assembled on scene within *adopted public policy* time frames. An *initial* effective response force is that which will most likely stop the escalation of the emergency for each risk type.

For example, in urban/suburban areas, an initial effective response force is typically three to four units, all arriving within 10 minutes or less travel time. Such a response can *stop* the escalation of the emergency, even in a high-risk area. An initial effective response force is not necessarily the total number of units or personnel needed if the emergency escalated to the maximum potential.

For example, if a building pre-planned for a worst case scenario has a fire flow of 4,000 gpm (gallon per minute), it is possible for the jurisdiction to plan an initial effective response force to provide the gpm necessary (say 1,500 gpm) to contain the fire to a reasonably sized compartment of origin for initial attack, and to have further planned for multiple alarms to fill in the remainder of the fire flow demands if initial attack is unsuccessful. Additional alarms or units could be planned from farther away, using automatic and mutual aid. If risk is well defined within areas smaller than a fire company first-due area (demand zone, run box, CAD response grid, etc.), then the initial effective response force should be planned for the predominant risk type found. Historical fire data is used to match predicated response staffing to prior incident history and department standard operating procedures. This method is commonly called critical tasking.

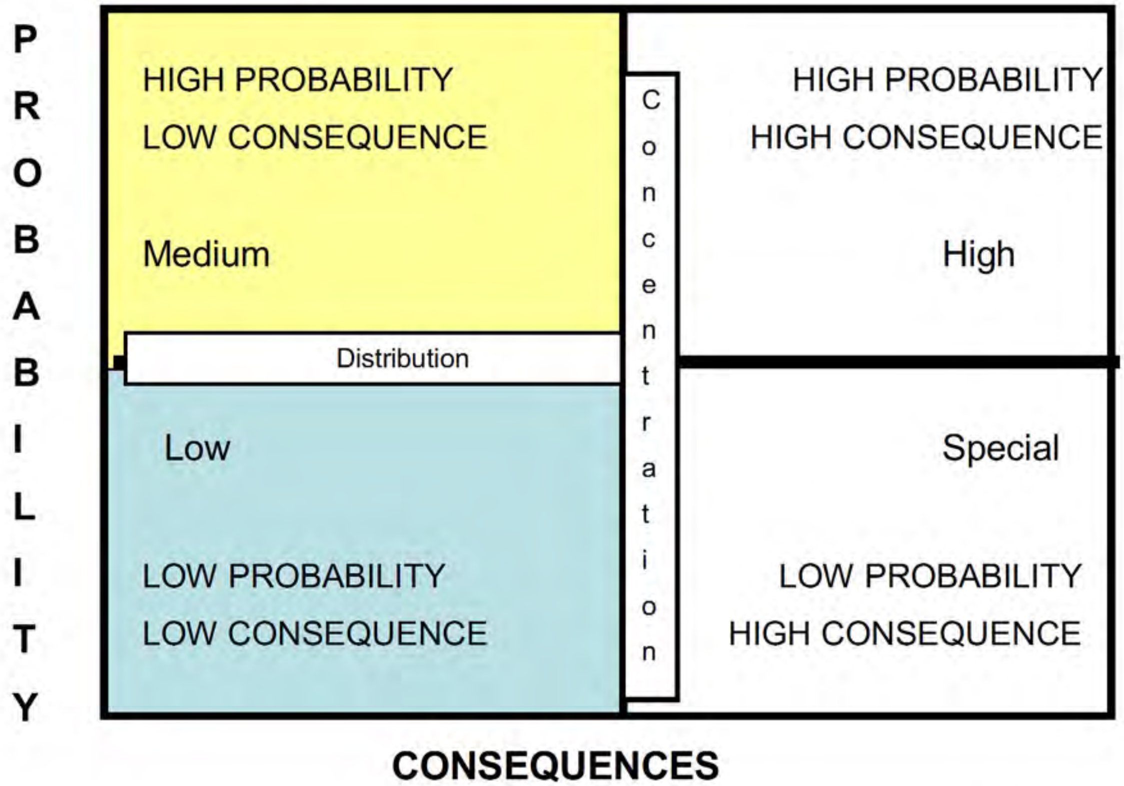
Concentration is measured by risk category type — high-risk areas need second and third-due units in shorter time frames than in typical or low-risk areas.

A sample standards of cover policy statement on concentration could be:

> *That in a maximum risk area, an initial effective response force shall arrive within 10 minutes total reflex time, 90 percent of the time and be able to provide 1,500 gpm for fire fighting, or be able to handle a five-patient emergency medical incident.*

Concentration statements, like distribution statements, have very specific grammar and structure. They must have a fractile performance measure and a time measure - either total reflex or travel. The performance measure is for the initial effective response force that may not finish the job without additional help, but is designed to stop the escalation of the emergency. For example, the force (first alarm) is designed to stop fires, historically, found in each risk category, not the worst fire flow expected. The force may call for additional aid to help finish such tasks as overhaul, or to provide crew rest rotations.

Figure 101: Distribution/Concentration Matrix



Concentration pushes and pulls distribution; there is no one perfect mathematical solution. Each agency, after risk assessment and critical task analysis, must be able to quantify and articulate why its resource allocation methodology meets the governing body's adopted policies for initial effective intervention on both a first-due and multiple-unit basis.

Performance Reliability

This section looks at actual incident history data to measure historical performance. If your agency states it does something within X-minutes, Z percent of the time, does it? The reliability of the response system is evaluated. Does the agency frequently see multiple calls for service (stacked or queued calls), and do these degrade performance? Are there predictable times of the day, week, or year when queued calls occur? Can these occurrences be controlled or can peak hour staffing be used? For example, in some areas in the summer during extreme fire weather conditions, additional crews are placed into service for the worst part of the day. In a similar manner, EMS peak hour incident needs can be handled by additional, part-time units. In essence the methodology looks at outcomes and determines if the standard of coverage is achieving the community's expectations.

6. Critical Task Analysis

The scene of an emergency is by definition, organized chaos. It is extremely important to study the sequence and nature of the primary or critical tasks that much be performed in order to bring the emergency to a positive conclusion. This is Critical Task Analysis. Use of this analysis will determine the number, type, and timing of needed resources to accomplish the tasks at hand. Because the equipment, training, procedures, and knowledge differ from one organization to another, this process should be accomplished by each organization as it moves through the SOC process. While most are similar, difference will occur.

7. Overall Evaluation

Once all the individual standards of coverage factors are understood and measured, an overall, comprehensive evaluation must be conducted. This is where the professional fire officer's experience in his/her community is needed. We have all heard the term "garbage-in, garbage-out." Well, all the statistics may say one thing, but they may totally disagree with real world experience. If so, find out why and keep studying until the numbers come close to reality. Then based on good data, compare and contrast the study findings to community needs, expectations, and the ability to afford. All elected officials should be presented with a cost-benefit analysis, not just a demand for a change! The decision-making body should also adopt the performance measures identified in the process.

8. Compliance Methodology

Finally, it is extremely important that a methodology is established for the continued measurement of performance and the adjustment of the delivery system when needed to attain the performance desired. This is accomplished by detailing the methodology that will be used in the evaluation of the organizations performance in the future. Good compliance system will have monthly, quarterly, and annual components to them as well as long term plans to revisit the entire SOC process. It is important to remember that, *what gets measured; gets done*.

Summary

Fire departments have been building fire stations and staffing them in this country for more than 250 years. Benjamin Franklin probably did not have much discussion about where to place his first fire company in Philadelphia. Today, there are a wide variety of reasons to place emphasis on this methodology. Among the top contenders for the prime reason is fire department performance in a contemporary fire service. Placement and staffing of fire companies is not as simple as it once was, but it is not as complicated as some would have it be. Standards of response coverage are merely a rational and systematic way of looking at the basic service provided by a fire agency - emergency services.

Appendix B: Deccan Software

Deccan International, founded in 1995, is a software company focused on developing and applying practical, data based tools and analysis for enabling fire fighting, ambulance and 911, operations to become more efficient. Dr. Raj Nagaraj, Director of Engineering and Research, is an Industrial Engineer who has designed and managed award winning productivity improvement projects in all three types of operations. He has built a 20-year record of accomplishment using industrial engineering techniques to help ambulance operations, 911 communications centers, and fire departments reinvent their operations.

CAD Analyst

CAD Analyst is a Performance Analysis system. It is "mapping based" software that runs on the Windows environment using another program called MapInfo. The CAD Analyst software is used to calculate workload and performance, then display the result in both text and graphic outputs. The User can adjust the criteria in the calculation to see what the overall and specific result would be when applied. The overall system performance is then shown in a text report. Performance for each grid is shown on a thematic (color coded) map. Workloads are shown in the same manner.

CAD Analyst features include:

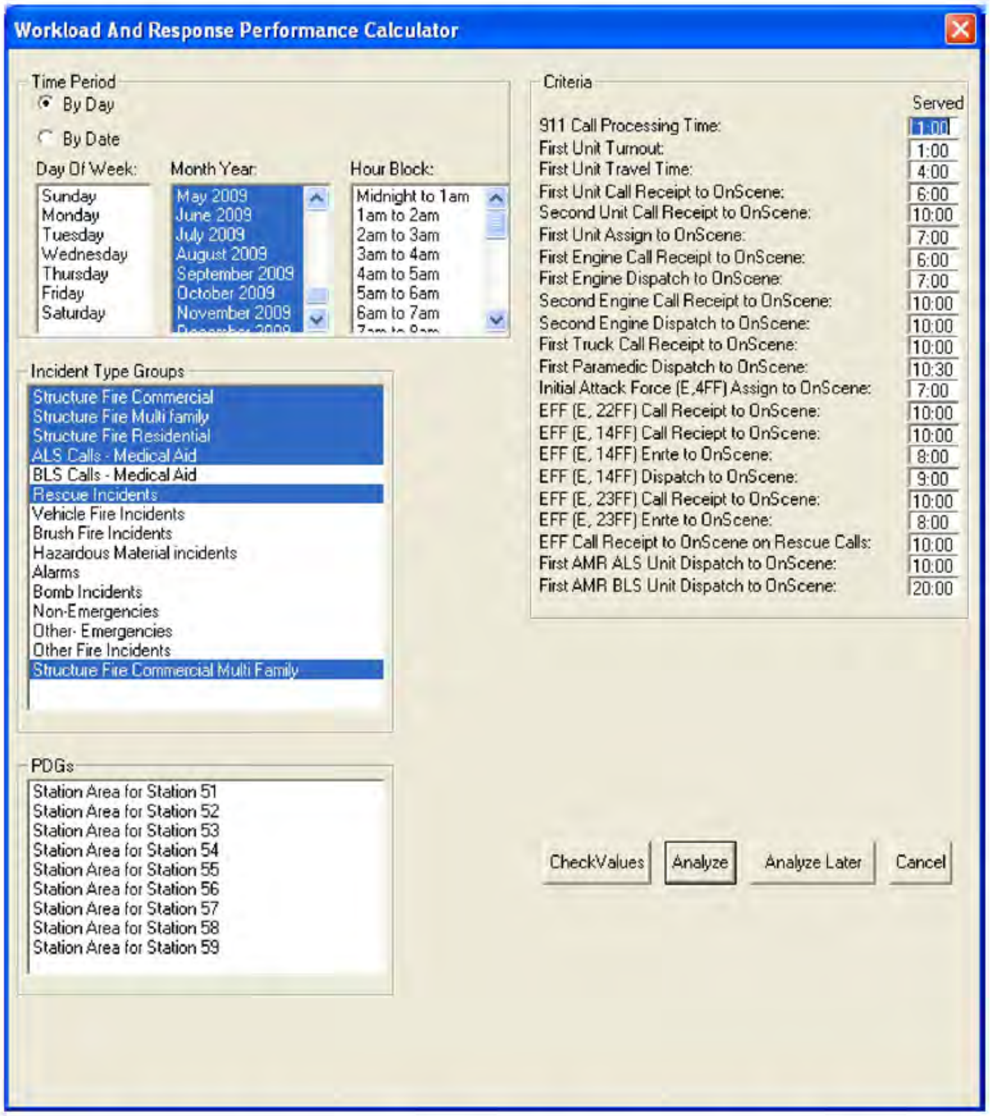
- Workload and Response Performance calculator
- Average Performance results
- Fractal Performance results
- Agency Level Performance results
- Grid Specific Performance results
- Printable maps and data for each criterion
- Summary maps for workload and risk inputs.

Users can print maps for each performance. Using CAD Analyst, the fire chief or any other user can analyze last year's workloads and response performances for rescue calls, during morning rush, in the weekdays, during the summer. The results would be available in just a few minutes with all of the detail.

It is important to note that these calculations are based on the actual data/calls. These are not projections, estimates, or annualized factors. All calculations are run directly from the call database and contain the entire call data for each incident in the analysis.

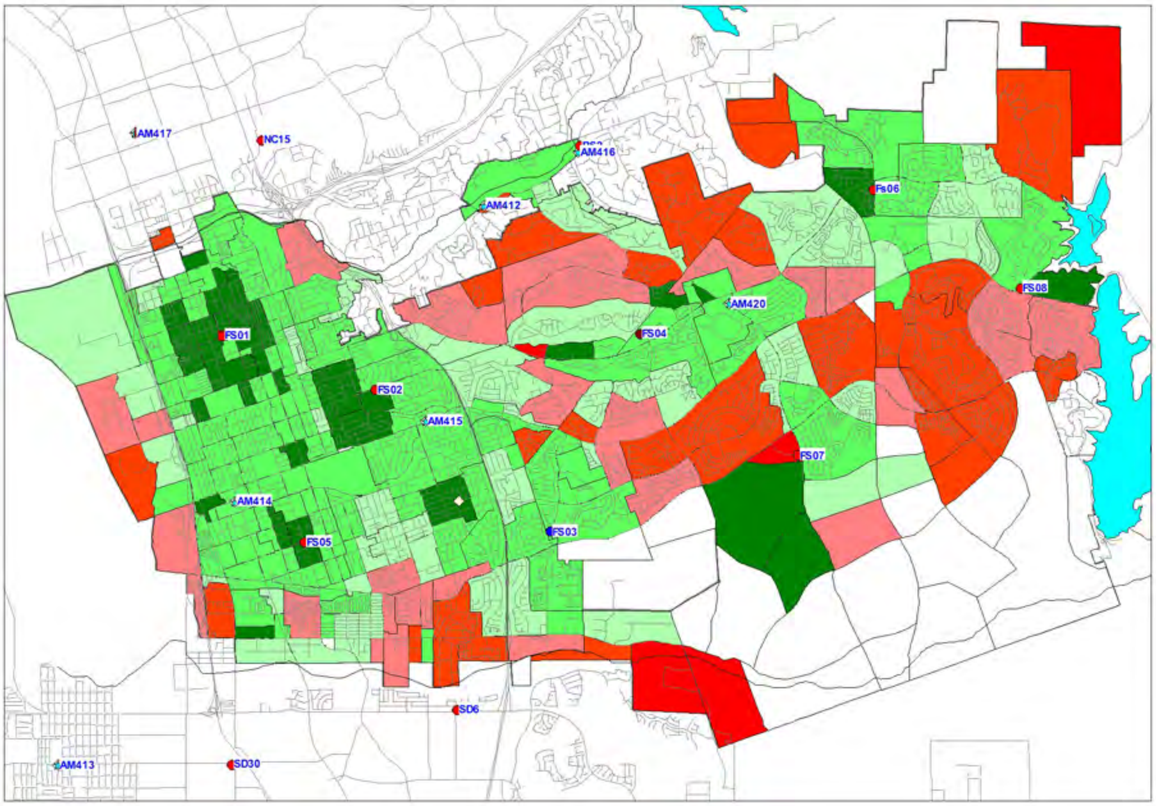
Here are specific examples of the software capabilities:

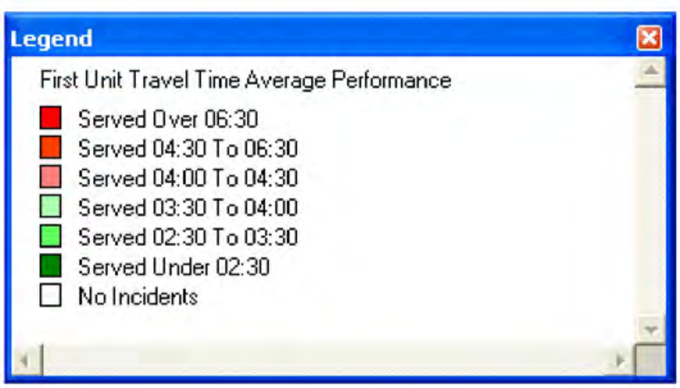
Workload and Response Performance calculator: This feature that lets a User specify the specific days-of-the-week, times-of-the-day, seasons of the year, and incident type groups to be calculated. CAD Analyst then extracts the incidents during that time period for the type(s) of calls indicated and displays the results thematically in a map. Additionally, the User can change the time standards for each of the pre-identified interval in the response standards adopted by the City and recalculate the performance.



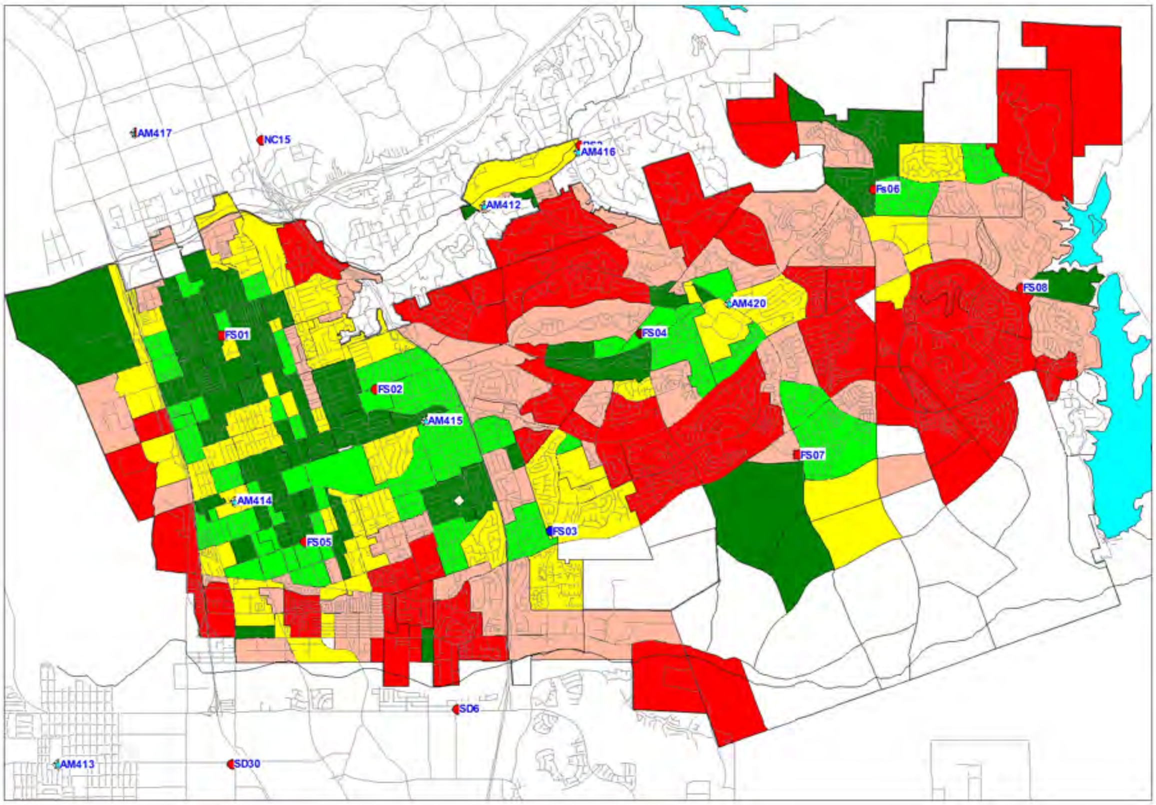
This tool allow the user to formulate a matrix of performance that shows the current performance and can be used in the "Standards of Cover" process to determine the exact nature of the proposed service level if it has not been achieved. For example: If the performance measure is the 90th percentile and the current performance is less than 90. The user can continue to change the test value until the 90th percentile is reach. This will demonstrate the performance gap that existing with the current resources/deployment.

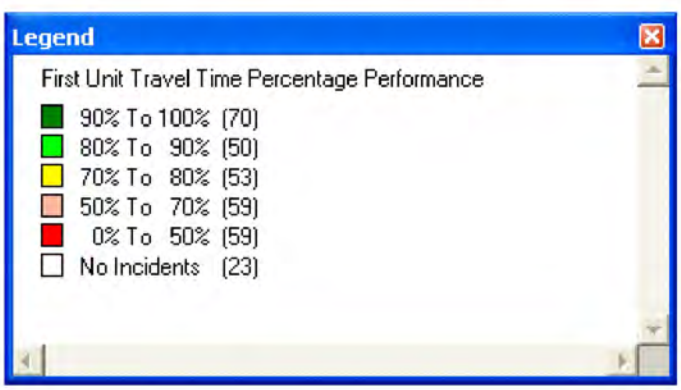
Average Performance. The software lets a user look at specific response type performances such as average First Unit, First Ambulance, First Truck, Second Engine on scene, and shows the performance in both time and percentage for both the system-wide and grid level. The performances are thematically displayed in an easy to understand manner. Green means performance with the standard chosen and red indicates performance greater than the standard chosen.





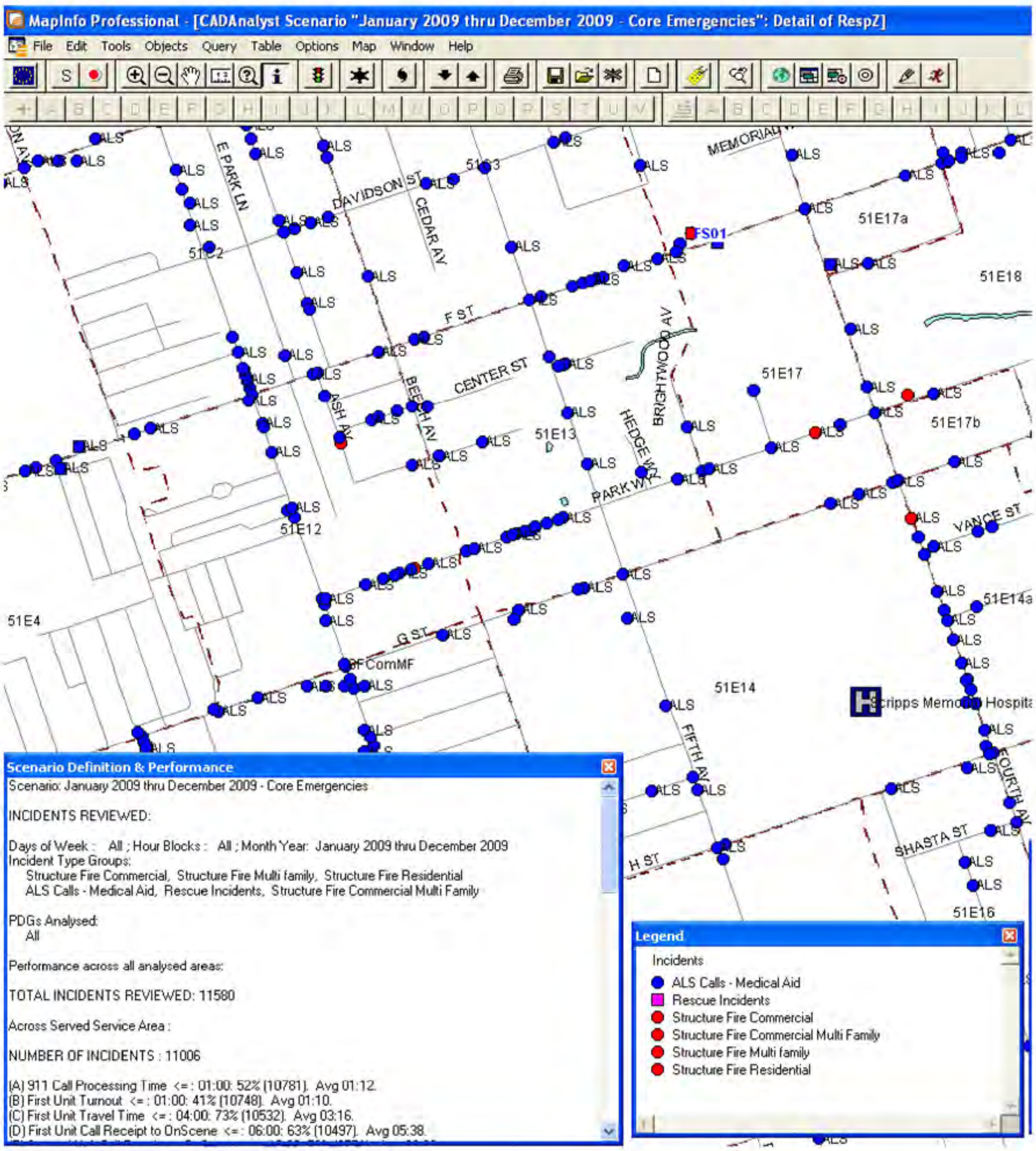
Fractal Performance. Similar to average performance except that performance is calculated based on the ranking of the calls rather than to averaging of the data. In this case, a score of 80 percent means that 8 out of 10 calls actually meet the criteria. In the average performance, all the calls were averaged and the combined score used in the calculation. Fractal performance is a much higher standard to achieve. It also has a diminishing return on investment of resources.



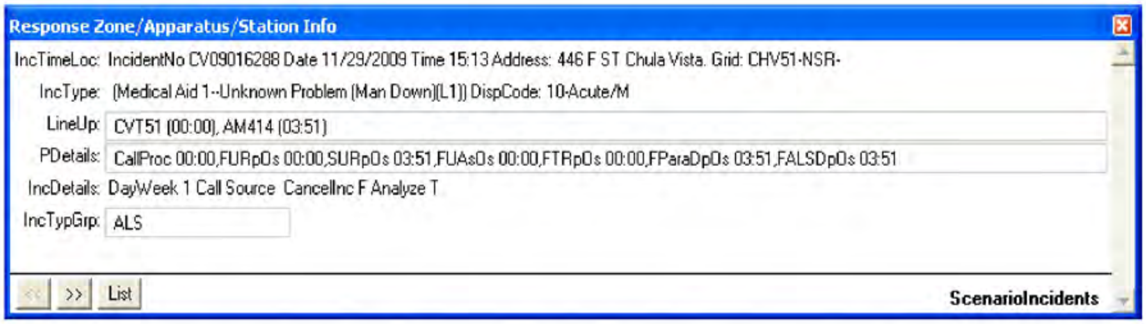


Specific Performance. Through the use of the Zoom button the User can zoom into a particular area of the response area, and views all the incidents in that zone. Each incident is colored-coded to show what type of call it is. The first call for that location is labeled. The User can click on the call to get all details on that incident including incident number, date of incident, location, etc.

District Level Data



Incident Data Level



All of the data resides within the system. Location, time, date, units that responded, timeframes that it took to process the call, have unit go Enroute, arrive at scene and the total amount of time units where committed to this incident.

Fire/EMS ADAM

Fire/EMS ADAM is a Deployment Analysis system. Using the results derived from CAD Analyst, Deccan creates the appropriate workloads for each grid and travel speeds for each unit type and geographic area. Then, using a street map, the computer calculates the response time (based on actual performance in the past) as well as each current and proposed fire station locations. The model is then calibrated, so that response performance projections for the current location scenario closely match actual recorded performance in CAD Analyst. The software is now ready to model changes in the deployment.

Fire/EMS ADAM runs in the Windows environment. It, like CAD Analyst, runs within another program called MapInfo (GIS program). The program enables the user to specify alternate fire apparatus types and/or locations by merely "dragging" apparatus with a mouse from one location to another or by using interface windows. The software then automatically recalculates and graphically displays response performance for each of the time standards in each of the pre-identified intervals for the response standards adopted by the City.

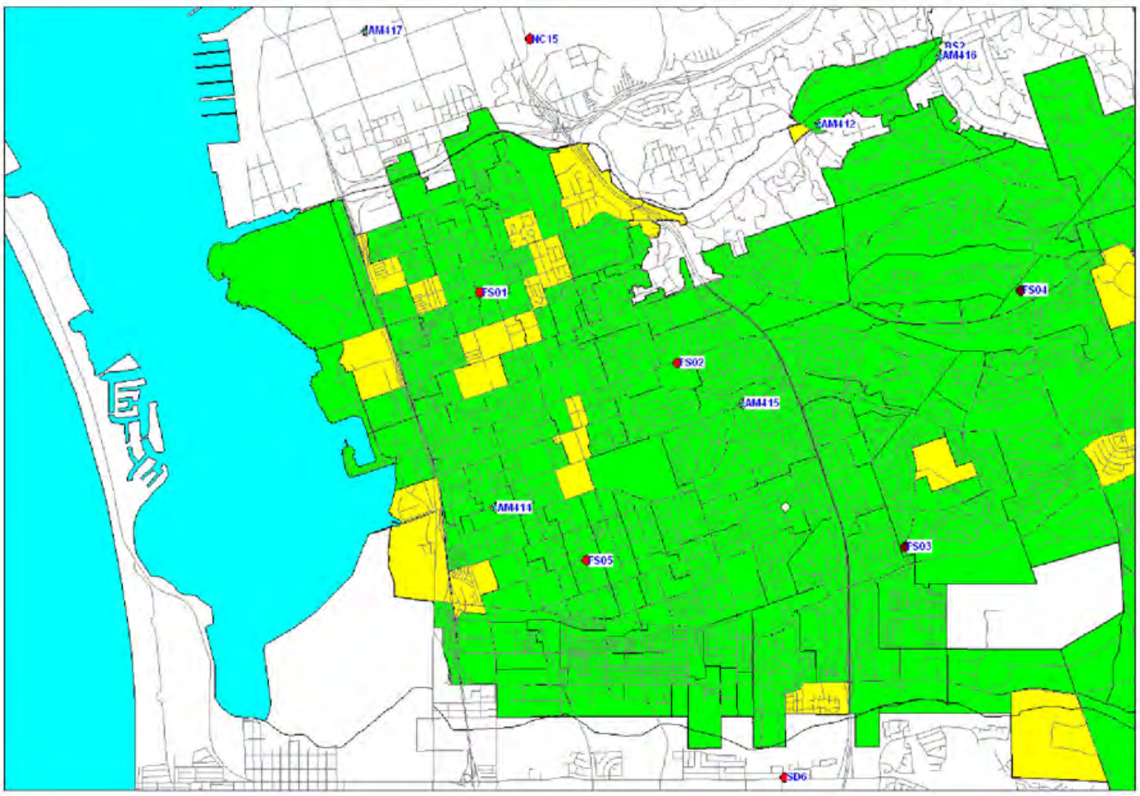
Fire/EMS ADAM features include:

- The model uses real data to provide estimates. The software estimates call-to-scene times for new location scenarios based on past history, with assumptions related such things as speed limits or grade included based on the users preferences. Travel distances are based on the actual or proposed street system and not "as the crow flies." The estimates for apparatus workloads (run-loads and apparatus availability) for new location scenarios are based on the actual, historical distribution of incidents. Several different base maps can be used for planning activities and the impacts of future transportation links.
- Calculates both average and fractal response performance to each zone or grid within the service area. Criteria for each grid is based on the risk level assigned to the specific

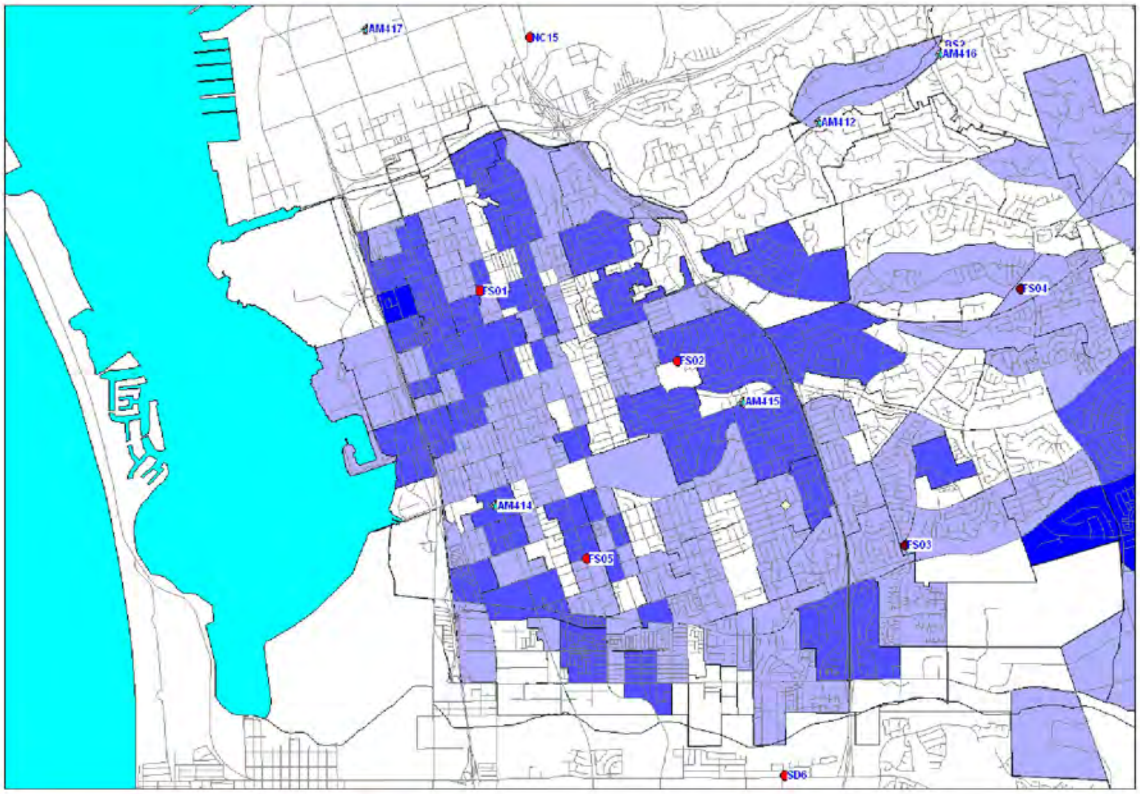
grid rather than some overall calculation.

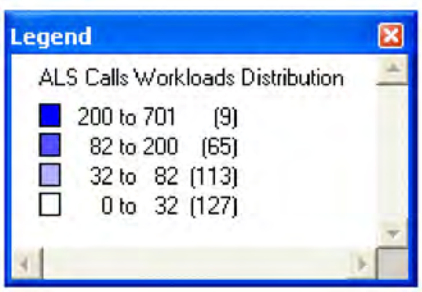
- Displays separate response performances for fire, medical incidents, rescue and wildland as defined by the user (up to 40 parameters).
- User can delete, save, retrieve and even build upon each of the different analysis scenarios. With the add-on software from ESCi, scenarios can be compared directly with outputs showing only the changes between the two scenarios.
- The software produces color-coded outputs for Hazard Class (risk), Workload, First Due Units, and Performance or the ability of that area to be served with the response time goals.

Risk Categories

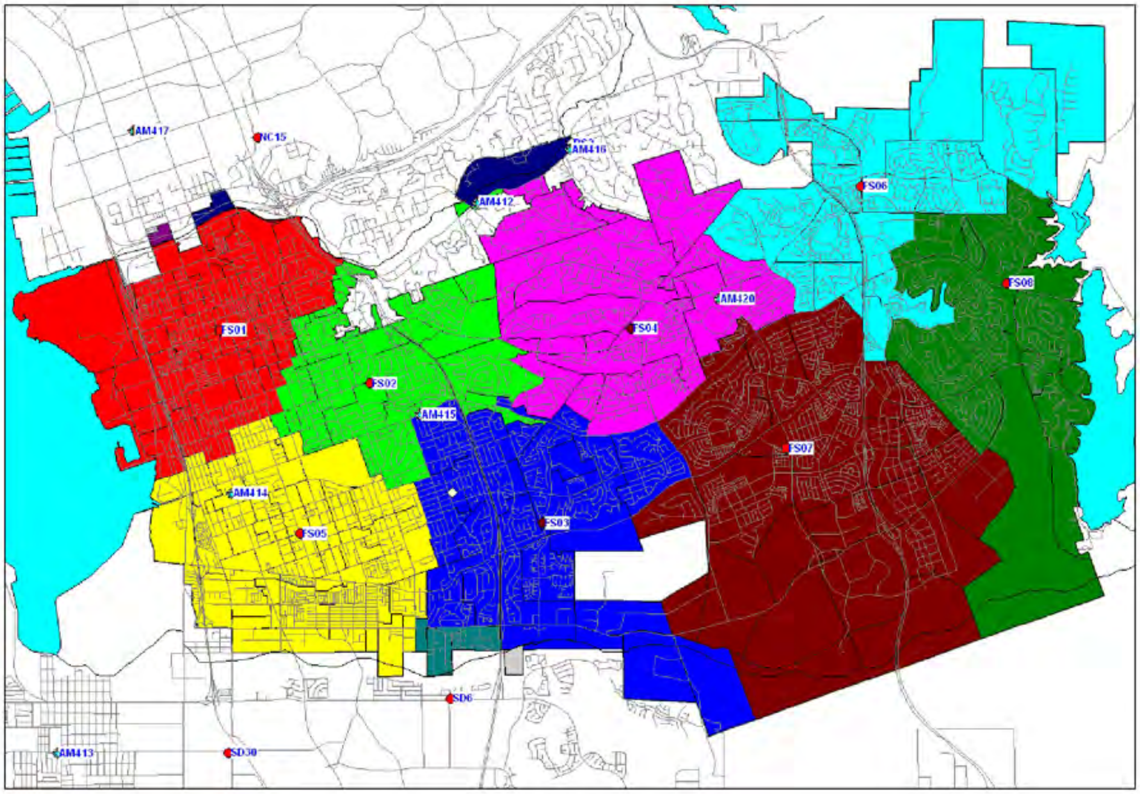


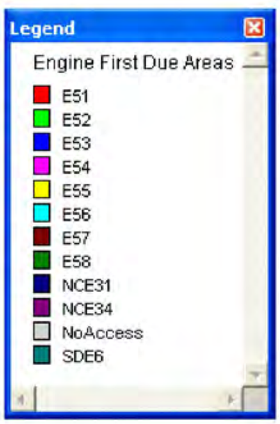
Workload Outputs



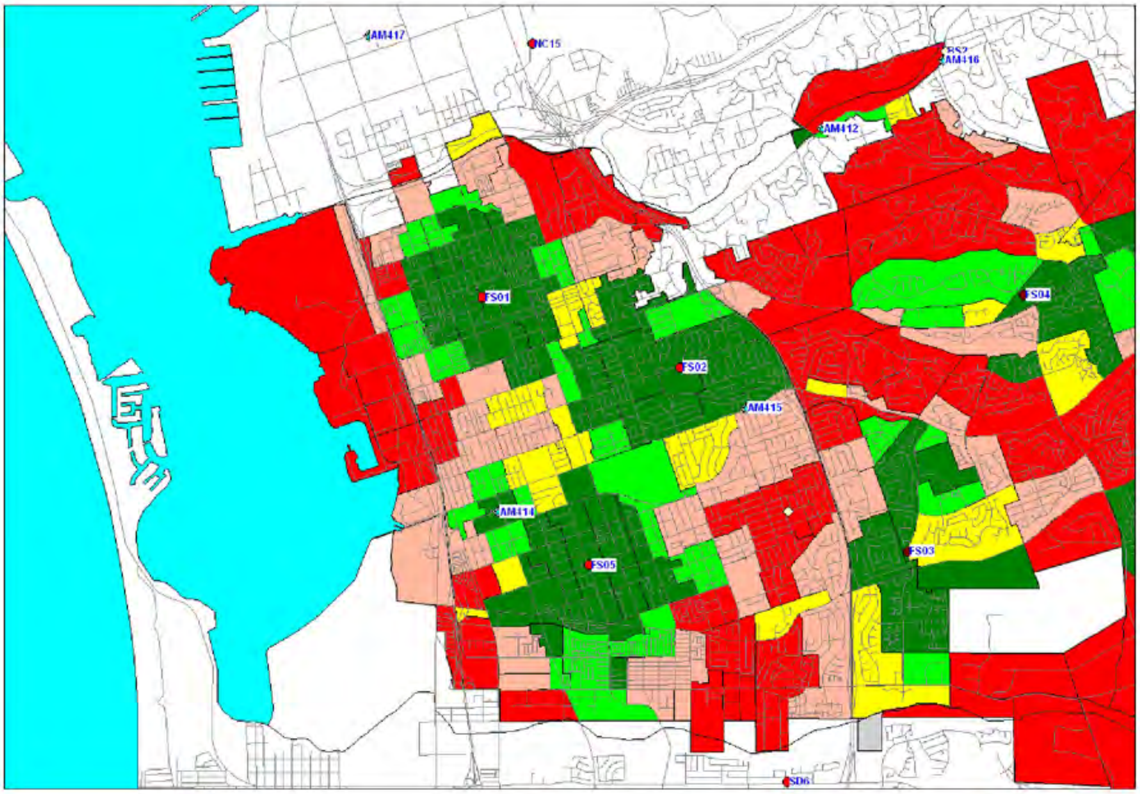


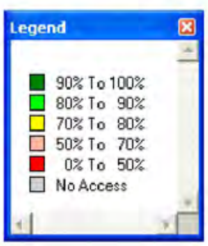
First Due Areas (Engine first due areas shown for baseline deployment)

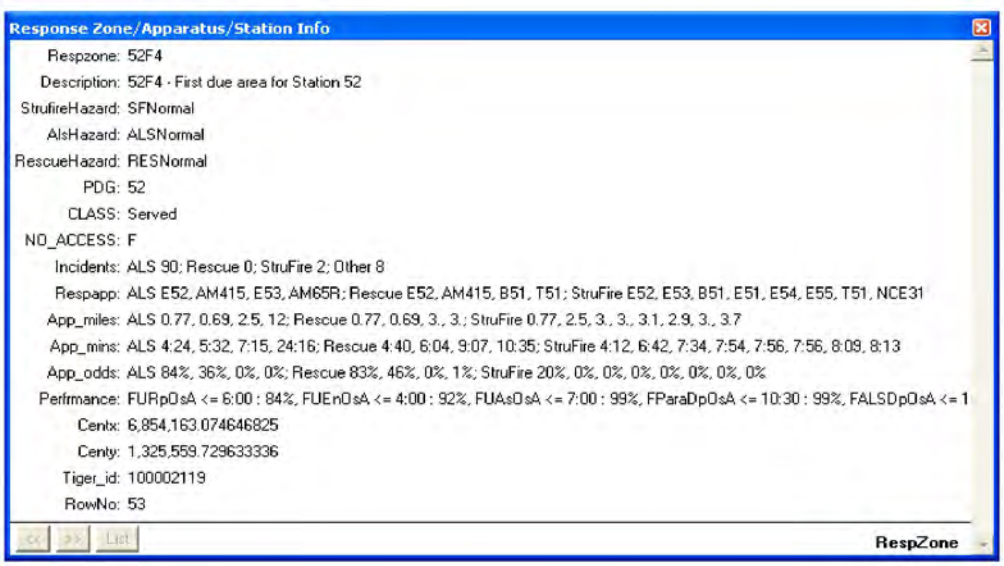




Performance (First Unit on ALS calls)






Response Zone/Apparatus/Station Info

Respzone:	52F4
Description:	52F4 - First due area for Station 52
StrufireHazard:	SFNormal
AlsHazard:	ALSNormal
RescueHazard:	RESNormal
PDG:	52
CLASS:	Served
NO_ACCESS:	F
Incidents:	ALS 90; Rescue 0; StruFire 2; Other 8
Respapp:	ALS E52, AM415, E53, AM65R; Rescue E52, AM415, B51, T51; StruFire E52, E53, B51, E51, E54, E55, T51, NCE31
App_miles:	ALS 0.77, 0.69, 2.5, 12; Rescue 0.77, 0.69, 3., 3.; StruFire 0.77, 2.5, 3., 3., 3.1, 2.9, 3., 3.7
App_mins:	ALS 4:24, 5:32, 7:15, 24:16; Rescue 4:40, 6:04, 9:07, 10:35; StruFire 4:12, 6:42, 7:34, 7:54, 7:56, 7:56, 8:09, 8:13
App_odds:	ALS 84%, 36%, 0%, 0%; Rescue 83%, 46%, 0%, 1%; StruFire 20%, 0%, 0%, 0%, 0%, 0%, 0%, 0%
Perfrmance:	FURpOsA <= 6:00 : 84%, FUEnOsA <= 4:00 : 92%, FUAsOsA <= 7:00 : 99%, FParaDpOsA <= 10:30 : 99%, FALSDpOsA <= 1
Centx:	6,854,163.074646825
Centy:	1,325,559.729633336
Tiger_id:	100002119
RowNo:	53

<< >> List RespZone